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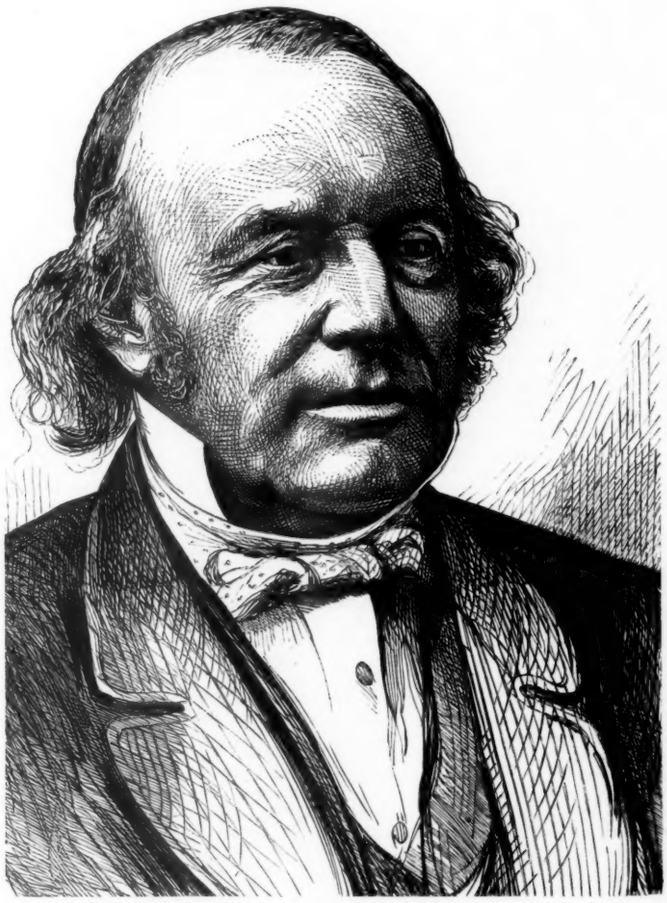

PROFESSOR LOUIS AGASSIZ.

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THE name of Professor Agassiz—the "counterfeit presentment" of whose face and frame, remarkable alike for their physical and intellectual massiveness and power, is herewith presented to the reader—is honourably associated with various spheres of scientific research. If, however, we wished to *focus* his several distinctions, we should find them all converging to a centre in which he would be recognized as the Newton of fossil ichthyology—as the original genius who, in the words of Dr. Buckland, "introduced an additional element into geological calculations, and brought an engine of great power, hitherto unapplied, to bear on the field of our enquiry, and seemed almost to add a new sense to our powers of geological perception."

The great naturalist descends from French Protestant ancestors, who, after the Revocation of the Edict of Nantes, took refuge in Switzerland, to the ranks of the reforming clergy of which country they largely contributed. The pastorate, indeed, had become almost a caste in the Agassiz family, whose devotion to the profession had been exemplified in five successive generations; and Louis himself was at first designed to perpetuate the paternal traditions. At the time of his birth, which took place on the 28th of May, 1807, "exactly a century after the birth of Linnæus," his father was in charge of the parish of Mottier, in the canton of Friburg, from which he was afterwards called successively to the little town of Orbe, situated at the foot of the Jura, and to the parish of Concise, a large village on the Lake of Neufchâtel. Up to the age of eleven years the education of young Agassiz was conducted under the sole and immediate direction of his mother, who represented a family of physicians nearly as emphatically as her husband represented a family of clergymen; and from whom it is fair to suppose her son inherited those tendencies to scientific investigation which to-day have

placed his name high amongst the fellows of that "Solomon's House," so happily imagined by Lord Bacon in his "New Atlantis," "the end of whose foundation was the knowledge of causes and secret notions of things, and the enlarging of the bounds of human empire to the effecting of all things possible." In 1818, Agassiz became a pupil at the Gymnasium of Biel or Bienne, from which he was removed in 1822 to the academy of Lausanne. The neighbourhood of his father's residence to the Lake of Neufchâtel conclusively determined his studies to natural history, and especially to ichthyology; and, abandoning the idea of a commercial career, for which he had already changed his original dedication to the ministry, he adopted medicine as his profession. This adoption was, however, rather ostensible than real; for although he took the degree of M.D. with considerable distinction at Munich in 1830—in which year he also graduated as Ph.D., with a startling thesis entitled *Mens feminæ viri animo superior*—yet his favourite study, whether at the universities of Zürich, Heidelberg, Munich, or Vienna, was comparative anatomy, whilst his peculiar passion set uninterruptedly in the direction of ichthyology.

It was during his stay at Munich that he was entrusted by Martius with the preparation of an account of the 116 species of fishes, a large proportion of which had been previously unknown, collected by Spix in Brazilian waters. This, the first important result of the literary labour of Agassiz, was published with the title of "Pisces, &c., quos collegit et pingendos accedit Spix, descripsit Agassiz," folio, Munich, 1829-31, with nearly 100 lithographic plates; and it is remarkable as being the earliest exposition of those ideas on the classification of fish to which its author has always adhered. After ten years of further ichthyological research he commenced the publication of his "Histoire Naturelle des Poissons d'Eau douce de l'Europe Centrale," which had been announced in 1821, and the issue of which, in several illustrated parts, and in the languages of France, Germany, and England, was completed in 1845. The publication of the "Histoire Naturelle" was retarded by the production of a still more distinctive work entitled "Recherches sur les Poissons Fossiles," in fourteen *livraisons*, folio, Neufchâtel, 1832-42, which incorporated the results of investigations pursued in various countries of Europe, and which introduced clearness and light where previously had been obscurity. Specimens from the various deposits of Europe were to be found, in what we may call the pre-Agassiz period, scattered in various cabinets; but all attempts to arrange them under existing genera and families had failed. Nearly 8000 species of living fishes had come under the observation of Cuvier, when death deprived the world of that illustrious zoologist; but he was sensible of the imperfection of his system as applicable to fossil genera; and indeed no considerable results had been arrived at. Agassiz ere long matured a classification differing from the existing ones, and of the highest physiological and geological value, and comprising four orders, differenced by their scales—a test so sure that a single scale will often determine the genus, and even the species, with as much certainty as the shell of a mollusc would determine the genus or species of its inhabitant. These four orders are:—(1) The Placoïdians (πλάξ, a broad plate). These are chiefly characterized by a skin covered irregularly with enamelled plates, often of large size, but sometimes only developed in the form of small points, like the shagreen on the skin of many sharks and the thorny tubercles on the integument of rays. This order comprehends all the cartilaginous fishes of Cuvier, with the exception of the sturgeons. (2) The Ganoïdians (γάνος, splendour, from the brilliant surface of their enamel). These are characterized by angular scales, formed of horny or bony plates, protected by a thick layer of enamel. The Ganoïdians form upwards of sixty genera, of which fifty are extinct. (3) The Ctenoïdians (κτείς, a comb). The scales of these are pectinated on their posterior margin like the teeth of a comb. They are composed of laminæ of horn or bone, but have no enamel. The scale of a perch affords a familiar example of this construction; and the fishes of this order are the Acanthopterygians of Artedi and Cuvier, with the exception of those which have smooth scales, and with the addition of the Pleuronectes, or flat fishes, as they are vernacularly called. (4) The Cycloïdians (κύκλος, a circle). The general character of the scales of the families of this order is smoothness and a simple margin; though they are frequently ornamented or sculptured, as it were, with various figures or patterns on their upper surface. Laminæ of horn or bone without any enamel are the ingredients in their composition. The Cycloïdians of Agassiz are principally Malacopterygians, or soft-finned fishes, comprehending, however, in addition, all these families excluded from the Acanthopterygians of Cuvier; while the Pleuronectes, which are removed to the Ctenoïdians, must be deducted.

In 1834, Agassiz—who had by this time become Professor of Zoology at Neufchâtel—visited England, where he received all the assistance which the collections and museums of private individuals or of corporate bodies could render him; and where he added a knowledge of 250 new species of fossil fishes to the 600 with which the strata or the cabinets of the Continent had made him familiar. On the 5th of November, in the year just mentioned, he read a paper before the Geological Society of London, in which he gave an abstract of the results he had up to that time obtained, and of which the following sentences offer the most important generalization:—"It is to be observed that, in fishes, more considerable differences may be remarked within narrow geological limits than among inferior animals. We do not see in the class of fishes the same genera, nor even the same families, pervading the whole series of formations, as takes place among zoophytes and testacea. On the contrary, from one formation to another, this class is represented by very different genera, referable to families which soon become extinct, as if the complicated structure of a superior organization could not be long perpetuated without important modifications; or rather, as if animal life tended to a more rapid diversification in the superior orders of the animal kingdom, during equal periods of time, than in its lower grades. With respect to this, it is with fishes nearly as with mammifers and reptiles, whose species, for the most part but little extended, belong, at a short distance in the vertical series, to different genera, without passing insensibly from one formation to another, as is generally admitted to be the case with certain shells." "One of the most interesting facts"—we quote from the "Quarterly Review" of February, 1836—"which M. Agassiz has observed is, that he does not know a single species of fossil fish which is found successively in two formations, whilst he is acquainted with a great number which have a very considerable horizontal extent."

It is not necessary, and indeed it would be scarcely possible within our available limits, to mention all the works contributed by Professor Agassiz to the stored-up science of the world, and which have so splendidly marked the successive achievements of a gallant spirit winning its way, in obedience to an irresistible impulse, amid toil and difficulty, to the height on which stands the proud temple of Fame. It will be enough if we add to the already enumerated list of his literary distinctions a work which in a remarkable degree extended and consolidated his reputation, and which bears the title of "Nouvelles Etudes sur les Glaciers," 1847; and a magnificent undertaking, which is now in progress, and which is to be completed in ten volumes in imperial quarto, entitled "Contributions to the Natural History of the United States."

In 1846, Professor Agassiz paid a visit to North America, and, after delivering a course of lectures in the Lowell Institute, Boston, and spending several months in connection with the Coast Survey, was appointed, in December, 1847, to the Professorship of Zoology and Geology at Cambridge, the foremost position of its kind in the United States. "He delivered subsequently two other courses of lectures in the Lowell Institute; and has, in the successive years which have elapsed, visited and collected zoological specimens in every portion of the Atlantic and Gulf coasts, the valley of the Mississippi, and the great plains at the base of the Rocky Mountains; and has had collectors at work gathering for him all land and marine animals on the Pacific coast. His collections of animals, plants, and fossils far exceed in extent any others ever made in America, and in many particulars surpass those of any European cabinet or museum. He held for two winters (1852-4) the Professorship of Comparative Anatomy in the Medical School of Charleston, S.C., but resigned it on account of his health. Since 1855, though occasionally giving courses of lectures on his favourite topics, he has occupied almost his entire time in the duties of his professorship, in the arranging and cataloguing of his vast collection, for the reception of which liberal gentlemen of Boston have founded and endowed a 'Museum of Comparative Zoology,' and in the preparation of elaborate and extensive works on zoology and palæontology. In 1865 he visited Brazil, accompanied by an efficient corps of assistants; and, in a tour of eighteen months, explored very thoroughly the valley of the Amazinas and other portions of the empire. In 1868 he was appointed a non-resident Professor and Lecturer in Cornell University, Ithaca, N.Y." In addition to the foregoing particulars from the recently published edition of "Men of the Time," it may be said that the latest mention of his name of special interest to people in England has been the recent statement of his unavoidable and unwilling absence from the farewell demonstration in which Professor Tyndall reciprocated leave-takings with his American friends after his tour amongst them as a lecturer on scientific subjects.

Of the character of Professor Agassiz, his ardour, his readiness, his single-mindedness and simplicity, many illustrations might be given; and these might be indefinitely increased if they were allowed to be supplemented by stories either apocryphal or insufficiently authenticated. We content ourselves

with a short anecdote in the shape of an extract from the "New York Tribune":—"There is a story of a shrewd agent who tried vainly to buy the great naturalist for a winter's lectures. 'Why, sir, you will make more money than by ten years of this work,' he reasoned. 'But I have not time to make money,' said Agassiz. When will that generation of Americans be born who will not have time to make money, and who will prefer deep-sea dredging to building houses of sand on the shore?" The comparison here introduced will become intelligible when it is understood that it was written at a time—late in 1871—when Professor Agassiz was on the eve of engaging in the conduct of a deep-sea exploring expedition, involving arduous labour and care for a considerable period, and presenting objects of research analogous to those for which the *Challenger* expedition left our shores last Christmas under the conduct of Dr. Wyville Thomson.

THE FANCY PAPER AND CARDBOARD TRADES.

IT is not easy to determine what is included, or intended to be included, under the designation *stationery*. An Etymological Dictionary tells us that "A stationer was originally a bookseller, from occupying a stand or station as a shop; one who sells paper and other articles used in writing;" and that "stationery comprises the articles sold by stationers." Therefore, if a stationer sticks to his trade, he would sell writing-paper, envelopes, wrappers, account books, note and memorandum books, school ciphering and writing books, quill and other pens, ever-pointed and other pencils, ink and inkstands, pounce, blotting paper, sealing-wax, desk seals, pen-wipers, ink-erasers, pencil-erasers, pencil-sharpeners, manifold copiers, paper cases, stationery boxes, and the like. But few of them confine themselves within these limits. They tempt their customers also with albums, scrap-books, portfolios, music books, writing desks, pocket books, playing cards, visiting and address cards, card cases, lace paper, valentines, gilt and tinsel paper, tissue paper, drawing paper, wrapping paper of varied kinds, embossed cardboards, wedding stationery, gold and silver medallion wafers, porte-monnaies, paper boxes and cases in fanciful devices, drawing boards, crayons and other drawing materials, tracing-paper, showboard papers, printed blank forms, penknives and pen makers, postage stamps, receipt and bill stamps, paper ornaments, paper flowers, and other articles difficult to classify. Without dwelling on these diversified subjects, we shall find an abundance of instructive detail connected with the manufacture of useful and ornamental articles in paper, and in the cardboard which is made of paper. The manufacture of paper itself forms an important and distinct branch of industry, into which we do not here enter; it is an affair of vats, steam engines, rag boilers, and other large apparatus.

Concerning the multiplied uses of paper and pulp, Mr. Gladstone, in his speech relating to the removal of the paper duty in 1866, said:—"The House can hardly form an idea of the varied and multiplied uses to which paper and paper-pulp (papier-mâché) are applied. It appears in all sorts of forms. I have here a list of sixty-nine industries in which you would hardly expect much paper to be used (besides those in which its use is obvious and well known). Paper and papier-mâché are much employed by anatomists, who make artificial limbs of it; by telescope makers, boot and shoe makers, hat makers, japanned tray makers, porcelain and earthenware manufacturers, comb makers, doll makers, coach builders, boat and ship-builders, and many others whom I need not cite. I am told of one manufacturer who makes door-panels of paper; and he proposes to make coaches and carriages of the same material when the tax is repealed. I have made inquiries of a manufacturer concerning the number of industries to which paper and its pulp can be applied; but instead of giving the details, he said, 'Who can place limits to inventions and ingenious combinations, when we see india-rubber, so soft and pliable a substance, become harder than wood after a few preliminary processes?' I have heard only this morning of casks being made of paper combined with bitumen, that will resist a pressure of three hundred pounds on the square inch. These details are not without interest; and if I submit them to your attention, it is to prove to you that in abolishing the excise duty on paper, you will facilitate the creation of industries at present unthought of."

Setting aside the papier-mâché manufacture as being, like that of paper itself, suitable for distinct treatment if treated at all, let us take a rapid glance at what may be called the fancy paper trade and its offshoots, the cardboard and paper-box trades, in some of their multiplied diversities of form. How sheets of paper are ruled, for making account books and school writing books, we need not stop to inquire; ruling machines are simple in form and easily understood. How the sheets are cut to definite sizes and folded to form the recognized octavo and other designations, and bound into thin books and substantial volumes, we may likewise set aside as coming within the domain of manufacturing stationery; but the paper itself is adorned in a number of curious ways, and made up into a surprising variety of forms.

FANCY PAPER MANUFACTURES.

Manufactured articles thus designated are so many and varied that we can only touch upon the principal among them.

Coloured or Stained Papers.—These in their various kinds meet the eye in quite a kaleidoscope of gaieties. When without other adornment, the paper receives its colour by brushing one surface of each sheet with a pigment or stain of the proper tint, repeating the process more than once for the better kinds. The number of tints now producible is considerable, and the resources of the aniline or coal-tar group of colours are successfully brought into requisition. Some of the sheets being glazed or polished, while others are left in a more subdued or matt condition, many agreeable varieties of effect may be produced. These sheets of coloured paper are coming more and more extensively into demand, to give a neat and attractive appearance to the work of the confectioner, the button maker, the printer, the bookbinder, and other fabricants. *Paper staining*, as it is erroneously called, for making wall-papers or paper-hangings, is an application of this process on a large scale, seeing that the paper is painted, not stained. The old-fashioned way of proceeding, still adopted for choice and expensive patterns, is to engrave the device on a slab of wood, or to build it up of raised fillets of wire and slips of metal. The paper is laid down flat on a table; the coloured paint is brushed over a flat pad or cushion; the slab or block is dabbed down, face undermost, on the paint, with which the raised device becomes coated; and then this coating is transferred to the paper. The paper is shifted along the table, and new spaces treated in a similar way; and so on, until any degree of length is finished. If, as is nearly always the case, the pattern is in two or more colours, there must be an engraved block for each; and the paper passes as many times under the workman's hands as there are colours, the adjustment being each time carefully made, to insure that the colours shall "register" well together, or come into their proper places. On a large scale the operations are greatly expedited by the use of engraved cylinders instead of flat blocks; two or more such cylinders are provided, each of which supplies itself with paint of a particular colour; and an endless web of paper passes over them in regular order, receiving its full pattern or device in a wonderfully short space of time. The paper-hanging manufacture being a large branch of industry, separate and distinct from all others, we will not enter further into the subject here; what we have said has been with the intention of showing that coloured paper for fancy work usually receives its colours on one surface only, in the same manner as the ground colour of wall paper, and that coloured devices on the paper are produced by impressions from flat blocks or from engraved cylinders. If the paper is coloured or tinted throughout its substance, this requires that the colouring pigments should be introduced into the pulp of which the paper is made.

Marbled Paper.—This, much used by bookbinders, is produced in a very curious way. The name is not exactly suitable, seeing that few of the specimens are imitations of real marble; but it has gradually become applied to sheets of paper of which one surface is made to imitate any kind of stone or wood. Small brown spots on a light ground, marble veining on a shaded ground, curled patterns and wavy patterns, all are produced in great diversity. The colours are of the usual kinds, such as Naples yellow, yellow ochre, yellow lake, orpiment, verdigris, rose pink, red lead, carmine, terra di Sienna, Dutch pink, indigo, Prussian blue, verditer, umber, ivory black, &c.; they are ground up very fine with prepared wax and water and a few drops of alcohol. A solution of gum is made of gum tragacanth, alum, gall, and water, and placed in a trough or shallow flat vessel. Colour is thrown on the surface of this gum water, usually by striking a brush against a stick, so as to produce a shower of sprinkles. Pigments of different tints and different thicknesses or degrees of consistency are thrown on; some spread more than others, and thus a diversity of pattern is produced. Sometimes the colour is thrown on by means of a pencil of very long bristles; it is diversified by means of a rod, held upright and carried along amongst the colours in a wavy or spiral course; and it is further cut up into tortuous lines by passing a kind of comb along it. All this takes place on the surface of the gum solution in the vat. When the vat is prepared, a sheet of paper is laid down flat on the solution, care being taken that every part of the surface shall be wetted; the paper takes

up a layer of paint, fancifully disposed in a pattern or device, and is hung up to dry. In order that one colour may not be blended or confused with another, they are ground up with different liquids, some watery, some gummy, some oily. The imitations of marble, grey and red granite, and fancy woods, are certainly not very faithful; but the paper is lively in appearance, and remains clean and bright a long time when polished. This polishing is effected by moistening the coloured surface of the paper with a little soap, and rubbing it with a piece of smooth marble, an ivory knob, a glass ball, or an agate burnisher. Beautiful products have been introduced within the last few years by Messrs. Delarue and other firms, under the names of *iridescent* and *opalescent* paper. Like the commoner kinds, these receive coloured devices on one surface; but great delicacy and care are called for in the processes to produce the exquisite play of light and shade which suggests the names given to these varieties.

Lace and Perforated Papers.—These are among the prettiest materials now employed in fancy stationery, so light and delicate, and so successful the imitation produced. Half a century ago, the French made this pierced lace paper chiefly for ornamenting fruit packed in cardboard boxes; and later applications of the same material were used as ornaments for lamp shades, and as mounts for small religious pictures. About forty years ago, M. Rivière, a Swiss watchmaker settled in London, obtained a patent for a new mode of perforating zinc and other metallic sheets. The founder of the great firm of Delarue, recognizing the usefulness of this invention, purchased it for application in the fancy paper and cardboard trades. Perforated paper, whether called lace paper or not, is now manufactured in large quantity, and in almost infinitely varied forms, not only by the leading firm, but by many others. Some of the perforated cards and cardboards are used for embroidering on with silk and coloured beads; some as a lace bordering for note paper; some for lining and covering fancy boxes of various kinds.

Decorated Papers.—This, as a collective term, applies to many more varieties than the coloured, the marbled, and the perforated. Some are printed in gold or silver, with or without colours, by one or other of the numerous processes of chromo-lithography, surface printing, block printing, cylinder printing, and printing from woven wire. The silver varieties are usually in thin films of real silver, applied either as a leaf or as a powder; but the so-called gold is more generally an imitation by means of Dutch metal or bronze powder. Many kinds are embossed or grained by means of engraved rollers, plates, blocks, or dies; while other kinds are so pressed and varnished as to imitate morocco and russia leather. These and numerous other kinds of fancy paper are used to an enormous extent for covering and lining the cardboard boxes in which light and fanciful articles are now so frequently packed; many a pretty pattern of box or wrapper brings a sale for that which would find but a dull trade without such external adornment.

Japanese Paper.—This is one among many evidences of the ingenuity of the Asiatic nation to which it owes its name. The Japanese are well skilled in the manufacture of thin paper, and its application to numerous useful and ornamental purposes. Mr. Appell, who reported on this department of industry at the Paris Exhibition in 1867, said:—"The Japanese use principally for making paper and paper cloth the bark and wood of the paper mulberry tree (*Broussonetia papyrifera*), the fibres of which are extremely tenacious. Their excellent paper, of which there are ninety different sorts, serves them for a variety of purposes unheard of among Europeans, even in this paper age. They not only paper their rooms, as we do; they also have paper garments, paper handkerchiefs, paper rain-coats and umbrellas. Despatch boxes, reticules, tobacco pouches, and other objects, are made of a paper imitating leather; even soldiers' hats are of paper, and are considered sword-proof. There are gold-spangled and embossed complimentary papers; a large and very thin writing paper, which in Japan is sold (to foreigners) at the price of sixty cents per sheet; and another paper, as stout as cardboard, ornamented with gold figures, sold at the price of four francs a sheet. There is the handkerchief paper, the price of which is from two to seven cents for ten sheets; gelatine paper; a wrinkled wall-paper; paper for screens, sold at the price of ninety-seven cents for ten sheets; paper made to imitate morocco, &c. There is, besides, paper cloth, as strong as leather." Speaking of another Asiatic nation, the Hindoos, Mr. Appell notices the leaves on which their books are generally written. "These leaves, dotted with gold, are from a foot to a foot and a-half long, and several inches broad. The method of writing on these is singular. The Hindoos, after having formed the characters on the leaf, rub them over with a preparation of oil and charcoal, which renders them distinct and quite indelible."

Paper Curtains.—Messrs. Pavy and Pretto have recently introduced a remarkably elegant material for curtains and tapestries. They call it *felted fabric*, but this is not exactly a good name for it. It is a peculiarly made paper, something like Japanese, but having certain animal and vegetable substances mixed with the pulp, such as buffalo skin, intestine, nettle, grass, and bark. The various constituents are disintegrated, purified, bleached, rolled, pressed, and printed. The substance made from these materials is slightly elastic, not readily torn, resists warmth and sunshine without fading, and falls into graceful folds; a little dampness only makes it more yielding. It is made up into window curtains, roller blinds, bed curtains and valances, and wall coverings: these latter being more like the chintzes and tapestries of former days than the paper-hangings with which we are now familiar. The patterns resemble chintzes, brocaded Lyons silks, and cretonnes. The inventors intend to apply it to carpets, chair covers, sofa and couch covers, &c. It is printed in body colours, retains its brilliancy, and allows dust to be brushed off without sinking in. One of the uses here enumerated illustrates the singular way in which a particular fashion re-asserts itself, after having been long out of favour; tapestry hangings preceded wall-paper, and now wall-paper has to meet a new competitor in tapestried paper.

We might proceed farther in the enumeration of these fanciful papers, and speak of the Bavarian reversible lamp-shades; the *soufflet* and other paper cups to contain delicate confections for evening parties, to protect the glove of the guest from being soiled; watch pockets, cash bags, patterns for ladies' dresses, and even dresses themselves for evening wear. But let us on, and treat next of

Valentines.—Who can tell the extent to which fancy stationery now includes these emblems of fun and admiration, these formidable additions to the delivery work of the postman? The manufacture is enormous, giving employment to large bodies of persons in the later months of the year, and in January. One singularity about valentines is, that the persons to whom they are sent are supposed to be ignorant from whence they come; whether this ignorance is really so great as it seems must be determined by those individually concerned. It would take us too far from our immediate subject to narrate how that, long before the Christian era, there was a festival held at Rome in the middle of February, especially interesting to young men and maidens; how that the written names of young women were put into a box, and drawn out by the young men present, as a preliminary to love-making; how that, when the Papal Church was established in the same city, the priesthood sought to give a new tone to the custom by substituting the names of saints for those of young women; how that the people, not relishing this change, refused to adopt it; how that the tendency crystallized into a usage of young persons selecting their loves by a sort of lot, on or about the natal day of St. Valentine; how that this gradually led to the transmission of love-verses on the auspicious day, and finally developed into the present custom, which mixes up the sentimental, the elegant, and the vulgar in a heterogeneous manner. We only speak of valentines as articles of manufacture; and there can be no doubt that this branch of industry is now a large one. They are not made in large factories; small masters undertake the work, a portion of which is done at the humble homes of the workers, through the medium of middlemen and sub-middlemen. The better kinds are well printed, inscribed with love-verses written in a neat small hand by women, and adorned with lace-paper, satin, coloured sheet gelatine, and other elegances. Sentimentalisms appear in strong force: "hearts transfixed by darts; turtle doves apparently commiserating each other on the absurdity of the position they are made to occupy; a profusion of small fat boys, principally remarkable for their disinclination to patronise the cheap clothing establishments of the day; pretty but otherwise highly insipid young gentlemen; and mincing young ladies, looking fit for anything but useful domesticated wives." Much neatness and cleverness are shown in putting together the various pieces which compose the more costly specimens. Besides the lace paper and the coloured gelatine, there are colour-printed sheets of dainty devices, to be cut out with scissors; small pieces of silk, satin, velvet, and cambric, often painted by hand; embossed paper and card; gilt and silvered paper; and many other delicate materials. The head-artist or manager must have some taste, or at least inventive faculty, to lay the plan for building up the valentine out of its numerous pieces. When winter approaches the valentine-makers are ready with their new designs for the forthcoming 14th of February. Some of these novelties happening to hit the taste of the buyers, the sale is large and the profits ample; while others, fully equal or perhaps superior in artistic merit, fall dead upon the market, and are a source of considerable loss. Considerable success, during the last few years, has attended a style of valentine comprising a little mechanism, such as a slide or door revealing a second picture besides the principal

one, and involving a bit of fun or sarcasm. Some of the most costly valentines sell for ten or twenty guineas each; indeed, we have heard of one which mounted to a hundred guineas. The truth is, that many of these have become a mere pretext for making a costly present, quite apart from the sentimentalism of young men and maidens. At the other end of the scale—valentines at a halfpenny and a penny each—the taste displayed is certainly of a low order; staring bright colours are laid on by children, covering designs too often gross and reprehensible. The sixpenny and shilling valentines are, all things considered, the most fitting and reasonable specimens of this peculiar kind of missive. How many valentines are made in a year there are no means of ascertaining; those which the postmen or letter-sorters know to be valentines pass through the London post to the number of something like one million every Valentine's Day.

Envelopes.—It would be allowable to consign these to the domain of plain stationery, were it not for the elegances so often comprised. As to the processes of manufacture, the sheets of paper are cut to the required size and shape by suitable cutting apparatus; but it would be wholly impossible to describe, within a limited space, the action of the beautiful machines which crease, fold, gum, and fasten the envelopes. Those persons who visited the International Exhibition last year had ample means of seeing how the machines act; and, moreover, of comparing different machines used by different makers. The automatic action, and the nice adjustment of the successive processes, are only a little less wonderful than those of coining at the Mint. There was shown, also, the curious mode of giving the black border to mourning envelopes, and the imprinting of a coloured monogram on the flap.

Card and Cardboard Manufactures.

Without dwelling longer on the diversified ways in which fancy papers are employed, our subject invites us next to notice the application of this material, not in the form of thin paper, but when thickened and stiffened into the forms of cardboard, pasteboard, and the like.

Plain Cardboard.—Most kinds of cardboard are made of sheets of paper pasted together, and rolled or pressed in a variety of ways. From the thinnest and finest to the thickest and coarsest, all are made in this manner, except a few special kinds which are produced direct at the paper mill—a thick layer of pulp instead of the usual thin layer. It is not the cardboard itself, but the mode of practically bringing it into use, that involves details of an interesting character.

Playing Cards.—In whatever way regarded, playing cards are a remarkable article of manufacture. Their history forms the subject of volumes of no inconsiderable bulk. Whatever else may be in doubt, it is certain that such cards were known and in fashion many centuries ago; and that many changes have taken place in their meaning and character. All that we can do, however, in this place is to describe first, the cardboard employed; next, the devices selected; and then the mode of printing.

The cardboard consists of several thicknesses of paper, each large enough for forty cards (if for the plain cards of one pack), or of twelve cards (if for the court cards). The French and Russian cards are often very thin; but those made in England are in fourfold thickness—two sheets of cartridge paper to form the foundation, and two of finer texture for the fronts and backs. All the papers are purposely selected in reference to certain desirable qualities, especially those for the front and back, which must take paste and paint well, and must polish well. The sheets are opened out on a table, and the paste applied with a large soft brush. (Even many years ago, when the firm had not attained its present dimensions, Messrs. Delarue were accustomed to use up three hundred gallons of paste per day in their various cardboard and fancy paper manufactures!) The two inner sheets to form the foundation or main substance are, when pasted together, subjected to processes of cool drying, warm drying, and hydraulic pressure, until they became a thin, smooth, tough sheet. The sheets for the fronts and backs of the cards undergo much preparation before they are pasted on. If the cards are to be white, the paper receives a kind of siliceous or enamel coating, in order that the black and red pips of the plain cards and the gay colours of the court cards may come out sharp and clear. If the cards are to have coloured backs, a ground colour and one or more pattern colours are laid on in a way presently to be described. The outer sheets of paper when thus far prepared are pasted to the foundation; and then the fourfold paper, now become cardboard or carton, is dried and pressed in various ways, until it becomes dense and compact in surface.

The fronts or faces of the plain cards are simple enough; they represent merely red and black pips. Games of cards have been devised in some foreign countries in which the number of cards has varied from seventy-eight to a hundred and twenty; but the almost universal European number at present is fifty-two, of which forty are spotted or pip cards. The four suits used in Germany to be hearts, leaves, acorns, and bells; the Italians had cups, swords, clubs, and coins; other packs have, at different times and in different countries, had their pips made to represent melons, pineapples, heads, squares, ovals, fish, tortoises, boats, lions, axes, gods, horses, and other objects. Our cardmakers confine us to hearts, diamonds, clubs, and spades—two red and two black. For the sake of near-sighted persons, Messrs. Delarue some years ago introduced four colours for easier distinction: red hearts, blue diamonds, green clubs, and black spades; but the public did not view the novelty favourably, and it can hardly be said to have taken firm root.

The fronts or faces of the court cards have undergone quite as curious a series of changes as those of the pip cards. We call them kings, queens, and knaves; but they have not always been so called. Some of the old German cards had a king, an over officer, and a sub-officer; those of France had king, queen, and chevalier, or sometimes valet. There has always been a king among this pictorial company; but the other two personages have varied much in character. One remarkable old pack of cards, still preserved, with king, queen, and valet of each suit, gives all the twelve distinct names—Charlemagne, Cæsar, Alexander, and David; Judith, Rachel, Argine, and Pallas; La Hire, Hector, Lancelot, and Hogier. In the revolutionary days, the French substituted Molière, Lafontaine, Voltaire, and Rousseau for the four kings, and Prudence, Justice, Temperance, and Fortitude for the four queens. Another manœuvre was to substitute *genii* for kings, under the names of War, Arts, Peace, and Commerce; *liberties* for queens, under those of Literature, Religion, Marriage, and Professions; and *equalities* for knaves, under those of Duties, Ranks, Rights, and Races. A German firm introduced a pack with eight historically famous kings and queens; another German firm brought in Wellington and Blucher after the battle of Waterloo; another presented court costumes at four widely distant periods. The Americans made an attempt to substitute Washington, Adams, Franklin, and Lafayette for the four kings; Venus, Fortune, Ceres, and Minerva for the four queens; and four Indian chiefs for the four knaves. The leading English house has made many endeavours to accustom card-players to more graceful forms and more appropriate costumes. But no—all innovations have failed; the kings, queens, and knaves are as uncouth as ever, and seem likely so to continue.

The backs or under surfaces of the cards are, if not left white, adorned in any way that the maker pleases. Some of them have slight devices of lines, checquers and geometrical forms, in one or two colours on a coloured ground; but the better packs are gracefully adorned with flowers, foliage, berries, fruit, arabesque and moresque devices, initials, monograms, symbolic devices, engine-turned rose patterns, and beautiful intermixtures of gold with delicate yellow, blue, lilac, fawn, salmon, orange, pink, and other tints.

Thus much, then, for the faces of the plain cards, the faces of the court cards, and the backs of all of them. We have next to see how these devices are engraved, and how transferred to the cards. All the colouring and printing are done before the sheets of paper are pasted together into cardboard. The ground-colour of the backs is, as we have said, laid on with a brush, the whole of one surface of a sheet of paper being thus painted. The patterns and devices used to be transferred by stencilling; and this plan is still extensively adopted. The stencil consists of a sheet of thick paper, hardened and strengthened with oil paint, and cut with perforations corresponding with the device, one stencil for each colour. This stencil being laid down on the paper, colour mixed with size and paste is brushed over it, and made to pass through the perforations to the paper beneath. The outlines for the kings, queens, and knaves cannot well be transferred in this way. The devices for these are engraved on pear-tree blocks, from which they are transferred either by rubbing or by pressing. After many costly experiments, success has attended the endeavour to substitute oil colours for water or distemper colours. The device for this purpose is produced on copper or brass plates by engraving, electrotyping, and other processes; and then the printing is effected in the same way as other varieties of colour-printing, there being as many plates as there are colours, one for each.

When the stencilling and printing of the sheets of paper are completed and the sheets pasted together to form the carton, this carton is dried, pressed, rolled, rubbed, and polished until both surfaces are brought to the most perfect condition: brushes and hot-plates and smooth rollers of various kinds being

brought into requisition. The sheets of carton are cut into the proper sizes for cards. Every card is separately but quickly examined; the most perfect are made up into packs called Moguls; the next degree into packs called Harrys; while those in which the most defects can be detected, although such as would escape the notice of inexperienced eyes, become Highlanders—puzzling designations these, for which no good reason seems to be assignable. The best firms do not go beyond these three degrees; any cards still less perfect are sold to dealers, who dispose of them at low prices after doctoring them up in some way or other.

Enamelled Cards.—Address cards, business cards, complimentary cards, &c., have become an extensive branch of manufacture. Persons now in middle-age can recollect the time when such cards were produced from refuse cards of playing packs, before colouring; but Mr. Creswick, the paper-maker, resolved to adopt something better. He made cardboard of fine new paper, pressed and rolled it to a beautifully smooth surface, and cut it up accurately into cards of various sizes and designations, ready to receive the handiwork of the engraver and printer. An advance on this production, perfected within a comparatively recent period, is the *enamelled* card. Many years ago, colour-makers used to charge a guinea a pound for artificial sulphate of barytes, made from the natural carbonate, and purchased by artists as a permanent white pigment. Chemical improvements gradually brought down the price of this article from one guinea to sixpence per pound. Then it was that some of the cardmakers conceived the idea of coating the better kinds of address cards with a sort of enamel. An approach in this direction had been made somewhat earlier at Frankfort, by the use of Kremnitz white as the coating material; but a better white, more resembling enamel, was obtainable from the barytes. The same substance is now employed to give a glossy white surface to paper intended for satin-paper hangings, for delicate wrapping paper, and for paper to be printed in gold or bronze. The best enamelled cards now made in England are coated with Newton's thin films, under the name of *opaline enamel*—a singularly delicate and beautiful product.

Paper and Cardboard Boxes.

We must not tarry longer among the cards and cardboards used in a flat form; other curious manufactures in which great varieties of form and adornment are brought into requisition, call for a little notice.

Fancy Cardboard Boxes.—These, perhaps more generally known as *paper* boxes, constitute an article of considerable commercial importance in France, to which the names of *cartonnage* and *cartonnerie* are given. The custom of packing light and delicate goods in such boxes was adopted by our French neighbours earlier than by ourselves. The wholesale dealers in gloves, silks, ribbons, laces, and millinery introduced the practice. The trade is well organized in Paris, where it gives employment to many thousand persons. One branch is limited to elaborately finished and ornamented boxes for the display of artificial flowers, velvets, ribbons, satins, silk trimmings, *corbeilles* for presents, and other elegant fancy goods; a second relates to boxes and small ornaments for confectionery; a third makes the boxes for fans, gloves, and perfumery; a fourth is confined to large boxes for shawls and ribbons in the wholesale and export trade; a fifth manufactures the multitudinous pill-boxes and wafer-boxes with which we are all so familiar; while a sixth is the branch which relates to boxes for the trinkets, so varied and fanciful, sold in Paris at about a franc or a franc and a-half per box. These articles of French cartonnage are better made than in other countries, in relation both to the neatness of execution and to the elegant style of ornamentation. The fruit-dealers in some of the French provinces enclose their perishable produce in convenient and tasteful boxes made for the purpose at Bordeaux.

Although the manufacture originated in France, it has become a very large one in England; and our paper-box makers will not admit the superiority of their compeers across the Channel. The towns in which lace, hosiery, gloves, ribbons, &c., are largely made—such as Manchester, Nottingham, Leicester, Belfast, &c.—produce millions of paper and cardboard boxes every year; and so does Birmingham, for the countless little trinkets and articles of cheap jewellery. The cardboard or pasteboard employed varies in thickness or number of sheets, in quality of paper, and in smoothness of surface; but when once made its conversion into boxes is an affair of scissors, paste, size, and gum, requiring neatness of touch and handling, but calling for no detailed description. The subsequent adornment of the boxes is due to the application of paint, varnish, gold, silver, bronze, coloured gelatine films, stamping, embossing, &c., according to the style with which they are intended to tempt customers.

There are manufacturers in London, mostly in out-of-the-way streets and lanes, who make and sell small confectionery boxes for about three shillings a gross; and these farthing boxes are, in many instances, really very pretty, with their glazed paper surfaces, gilt paper edges, coloured lithographs on the covers, and transparent coloured gelatine adornments. Artists are constantly in the employ of such box makers, inventing new designs to catch the eye of the public. If a Princess Louise marries a Lorne, or a Moltke thrashes a Napoleon, or a Shah visits England, the artist impounds them at once, and transfers them to his lithographic stone; for the box maker well knows that the confectioner will buy more largely of him if the pictures on the boxes happen to tally with the current of popular interest at the time.

Pill-boxes.—Among the most remarkable departments of cardboard manufacture is that of pill-boxes, the neat, well-formed cylindered boxes which are invested with so much importance in the sick room. Before describing the mode of making them, a few words may be bestowed upon a very cheap kind of round box, made of wood in the form of shaving or scaleboard. A peculiar cutting instrument, something like a plane, is passed along a plank, from which it shaves off a film or thin veneer; and this is continued until the whole plank is planed away. Some of these scaleboards are as thin as the hundredth part of an inch; but the usual thickness is about the thirtieth or fortieth of an inch. In making small deep, square boxes of these thin films of wood, the film is cut to the proper size for one box; the piece is cut half through and turned up to form sides and ends; thin paper is pasted or glued on to fasten the meeting edges, and the same or another piece of paper may cover the whole if needed. Circular chip boxes, such as those in which ointment is mostly sold, are made in a singular way. Shavings are made equal in width to the diameter, others equal to its depth, and others equal to the depth of the lid. Circular pieces for the top and bottom are cut out of the first-named shavings by means of a punch and mallet. The chip for the vertical sides are cut to the proper length, and drawn between rollers to make them curl slightly; the edges are rapidly touched with hot glue, each strip is bent round within a tin box, and one of the circular discs is driven down to the bottom of it; by the time the glue is dry the box is made. A similar routine of processes produces the lid. Neat boxes of this kind are sold wholesale as low as a shilling a gross.

We may now transfer our attention from chip or scaleboard boxes to those of paper or cardboard. To make the smallest pill-boxes, white on the outside and pink within, sheets of thin paper pass through a remarkable series of operations. Some of the sheets are coated all over one surface with a hot solution of cochineal to give the pink tint; others are coated over one-fourth only of the surface. When these latter are dry the remaining three-fourths are coated with paste; a wooden roller is rolled over the paper, which coils round it, and the adjustment of paper, paint, and paste is so managed that there is produced a stiff tube of fourfold thickness of paper with a pink lining. The tube, about a foot long, is taken off the roller and laid aside to dry. When dried, the outside of the tube is polished, and, adjusted to a lathe, it is quickly cut up into pieces, each large enough for one box, a mandril being thrust through the tube to keep it steady. It is said that a broken bit of watch-spring, fixed in some sort of handle, effects this cutting better than any regularly-made knife or other costly instrument. Each piece thus cut off from the tube is a ring or bottomless box; and a shallower ring, but of slightly larger diameter, forms a topless lid. The sheets of paper which have been coated all over with the cochineal solution are pasted upon plain sheets, dried, pressed, and rolled, and thus formed into sheets of carton or cardboard pink on one surface and white on the other. Circular discs are punched out of these sheets to form the bottoms of the boxes and the tops of the lids; as they fit accurately, they are soon adjusted to their places.

Notwithstanding the many processes concerned in their production, these neat little pill-boxes are sold as low as sixpence per gross, or even less. Those of larger size, say for a dozen pills each, are made with the side of the lid flush with the side of the box, instead of projecting beyond it. In this case the box is made twice as thick as the lid, with the outer layer not extending up to the edge, but leaving a groove or rebate over which the lid can close. Such boxes are also made additionally attractive by a glazed black or purple band of paper pasted round the exterior, leaving the white edges to show by contrast. These larger boxes are usually left white in the inside, not coloured pink; but this is a mere matter of detail.

Many more products of ingenuity and taste in these branches of industry might possibly reward our trouble in writing and the reader's in perusing; but enough has been said to show how inexhaustible are the resources of the fancy-paper trade. Whether dextrous fingers are employed in making up the sheets of paper into graceful forms, or whether these sheets are com-

bined to form a thicker carton or cardboard before being so manipulated, the whole range of operations is interesting and important, involving a large amount of sunk and floating capital and giving employment to thousands of persons.

THE NEW EXPLOSIVE SUBSTANCES.

By M. Fernand Papillon.

(*Continued from p.* 301.)

III.

IT is not enough to know the effects of a new force that has been brought within our grasp; but to make it really useful we must study it under every aspect, and surprise its most hidden secrets. We see clearly enough how the ball strikes the practice-target, but what is happening in the mouth of the cannon itself? What gases are freed when the powder explodes? What is the temperature, the density, the pressure of these gases? In what manner is the impulsion communicated to the projectile? What must we allow to the guns themselves—that is to say, what connection is there between the force in question and the final result? These questions can only be resolved by successive trials; they can be completely solved only by aid of the mechanical theory of heat, which has already thrown light upon so many mysteries, and dissipated so many obscurities.

We may take it for granted that the combustion of gunpowder transforms about a third part only of the weight of the charge into gas; the rest is found in the ash or scoria that befouls the bore of the gun, being whirled round and round by the smoke, and which chiefly consists of sulphate and carbonate of potash. The gaseous products are composed principally of carbonic acid and of azote; the carbonic acid occupies half, the azote four-tenths, of the whole volume of the gas. Chilled to freezing point, and held with atmospheric pressure, these gases occupy in round numbers two hundred times the volume of the charge. The excessive temperature to which they are suddenly raised—some thousands of degrees—increases the expansive force enormously; to retain them in atmospheric pressure under a heat of, for example, 3,000° Beaumé, a space twelve times as large would be needed; that is, 2,400 times the volume of the charge. Now they are originally imprisoned in the firing chamber, whose capacity is still further diminished by the solid residuum of the powder. From this results a tension of from 4,000 to 5,000 atmospheres; the compressed wind revolts and bursts the door of its prison, hurling before it the object that closes the aperture. According to the composition of the gases of powder, we see that, in a great part, the explosion is due to the carbonic acid.

This is the same gas that violently blows the cork out of a seltzer water bottle, and we know that if the bottle has been properly filled, this light projectile is very capable of wounding—it is just like a cannon shot in miniature. To give an idea of what 5,000 atmospheres represents, we should call to mind that the pressure of one atmosphere upon all bodies is one kilogramme upon every square centimetre—10,000 kilogrammes, that is, upon each square metre. Now the hurricane in its greatest fury produces only a pressure of 283 kilogrammes upon the same surface—scarcely a thirty-sixth part of an atmosphere. The pressure that a cannon-ball undergoes at the first instant, and which hurls it out, surpasses, then, by 200,000 times the violence of a hurricane that will level houses and uproot trees.

How can we learn the true temperature of the combustion that enchains this tempest? To be set aflame, powder requires only a very moderate heat—300° at most; but its burning melts zinc, brass, copper-money, even copper; the bore of some of the bronze guns is sometimes melted in too prolonged and too quick firing. All this proves that during some instants it must produce a temperature bordering on 2,500°. To measure it accurately is almost impossible; we must draw a conclusion from the quantity of heat yielded in an average ambient. In 1857, M. Bunsen made this the subject of extremely precise experiments, with the assistance of a young Russian chemist, M. Schisehkof. According to them 1 kilogramme of powder unlocks, in burning, 620 calories—enough, that is, to put 620° of heat into 1 litre of water—and as the gases absorb five or six times less heat than an equal weight of water to be then heated, it follows that the 620 calories would suffice to raise the temperature to 3,000°.

We have seen that if the gases are confined in a very small space, such as the volume of a cartridge, there results a tension of from 4,000 to 5,000 atmospheres.[1] This pressure is produced in the twinkling of an eye, during the short instant when the powder catches fire and consumes, but it is diminished as quickly during the expansion of the gases which are dilated in propelling the bullet forward. The greater or lesser rapidity of the combustion ought evidently to exercise a large influence in the succession of pressures during the hundredth part of a second which the bullet takes in traversing the length of the bore; thus all manner of researches have been instituted to lessen the conditions that modify the inflammation and combustion of war powder.

It is clear that the deflagration of a whole charge is a complex phænomenon, where we ought to distinguish between all the different effects; at first as to what passes in each grain in a state of isolation, then the influence of the contact of grains in larger or smaller bulks. A grain of blasting powder, as large as a lentil, burns for scarcely the tenth part of a second; a globe of fire suddenly envelopes the grain, and is then stifled without one being able to see how the ignition is propagated. To cause this phænomenon to last a longer time, they expressly manufactured grains as large as one or two kilogrammes, and these lasted for several seconds; nevertheless, the flame always enveloped them in the twinkling of an eye; all that they were able to gather was that the combustion takes place tolerably regularly in a series of distinct skins or coatings. With prisms cut from gunpowder-coke, they found the speed of combustion to be from 1 to 2 centimetres per second. The rapidity with which the flame circulates through a heap of grain-powder is much greater; the fire runs several metres a second along a train, and up to 25 metres in tubes that are not filled. These experiments are dangerous, for the barrels often explode. The inflammation of the charge of a fire-arm does not then require the hundredth part of a second. However, we may be sure that light powders in fine grains burn much more rapidly, and free more gas than dense powder with big grains; the action is more sudden, but also as fatiguing for the arm. Moreover, the effect of these powders is more quickly exhausted than that of the large cannon powder, which burns longer, acts upon the ball in a more material manner, and finally produces the same effect, all the time being less trying to the breech of the gun. A too sudden initial pressures fatigues the weapon unnecessarily, since it is possible to impress the same speed on the projectile by a gradual and progressive impulsion. This is only an advantage in short weapons where the force must hasten to act upon the missile before it leaves the cannon. For this reason it was that gun-cotton and other quick-explosive agents did not tend to a revolution in fire-arms. The form of the charge, again, contributes to regulate the effects of the deflagration; the long charge, which is generally adopted at present, increases the speed of the projectile, by favouring the circulation of the flame. Finally, we know that we can notably slacken the inflammation of grained powder by mixing with it some dust that will close up the interstices of the grains; this is a way of diminishing the danger of explosion in magazines, but the powder has to be sifted before it can be used.[1]

How can we exactly measure the force of this dangerous agent? Is it not as if we wished to attach a dynamometer to the paw of an enraged lion? It has, however, been attempted. People first tried to determine by direct observation the tension of the gases in the chamber of the gun. The first experiments of any account are due to a man, curious and notable in very many respects.

Towards the end of the last century, Benjamin Thomson, Count Rumford, "philosopher and philanthropist," was at the head of the workshops of the military arsenal at Munich. After having served in the English army during the American war, he entered into the Bavarian service, where he became lieutenant-general, minister of war and director of police, and where he made many researches upon the nutritive power of alimentary substances, upon the means of economizing fuel, and a crowd of other things, the selection of which betokened a mind altogether out of the common run. Later on he fixed his residence in France, and married the widow of Lavoisier. He it was who, about the year 1798, had suspicions of the mechanical theory of heat in proving the heating of the metal during the boring of the cannon. To demonstrate that the source of the heat lay in the friction, he thought of this experiment:—in an iron cylinder, filled with water, a pestle was worked by horse-power for two and a half hours—at the end of this time the water boiled. All

[1] These calculations are merely approximate, for nothing yet proves that the physical laws on which these calculations are based, remain applicable to a temperature so elevated and a pressure so exceptional. Mariotte's law, notably, must be wrong for these pressures. Besides the phænomenon of dissociation brings fresh complications to arguments founded on the nature of the products of combustion.

[1] For this purpose they have prepared a dust or powder of wood charcoal, black-lead, powdered glass and other substances.

the world was astounded, and Count Rumford himself confessed that the result gave him a childish joy, "which I ought to have concealed," says he, "if I had been ambitious of the reputation of a grave philosopher." Having thus discovered an inexhaustible source of caloric, he drew from it the conclusion that heat is motion; but he found this process of heating to be scarcely economical, "for the simple combustion of a horse's forage would yield more heat than his labour can create." We see how often Rumford approached the great doctrine of equivalence which to-day governs the physical sciences. His celebrated experiments in powder were made in 1792 with a miniature cannon, vertically placed, and the mouth of which was closed by an enormous weight, that the explosion of the powder was obliged to lift.

With a charge of six decigrammes of powder he obtained only a feeble noise, and the weight was scarcely stirred. When at the end of five minutes it was raised a jet of gas escaped, and the bore of the cannon was found to be obstructed by a very hard solid matter, which they were obliged to take off with a borer. Reassured by this result they trebled the charge—there was still scarcely the report of a little pocket-pistol;—this time the little forged iron cannon was burst, and the two pieces thrown to a distance. The tension of the gas which had produced the fracture of the iron must, according to Rumford's estimate, have been 55,000 atmospheres. This calculation resulted, it is true, from a line of argument of too little precision, judging from the conditions of other experiments. General Probert has demonstrated that the pressure could certainly not have been over 12,000 atmospheres. In the later experiments of Rumford, the weight at the top of the cannon yielded to an inferior pressure of only 10,000 atmospheres. Nevertheless, always thinking of the results he had deduced from the first rupture of the little cannon, he forced or doctored his figures, and found himself led to take 100,000 atmospheres as the maximum effect of the gases.

Among the more recent experiments that have been made with a view to measure the tension of gases in the interior of the cannon, we must cite those of Major Rodman, undertaken in 1857 in the United States in aid of his invention, that bears his own name. The *Rodman Punch* is a piston which crosses a canal, bored in some part of the body of the cannon, and which, pushed forward by the gas, makes an indentation in a cake of soft copper, the depth of the indentation being the test of the pressure. The results obtained by the inventor were rather disconnected, and inspired no great confidence.[1] Rarely, indeed, do we see any really scientific work produced in America; they work there too fast, and they are too easily satisfied. At the same time, Major Rodman's apparatus was based upon an ingenious idea. It was perfected in England, where they substituted for the cake of copper which received the imprint of the punch, a little copper cylinder which the piston crushed when the rod was pushed forward by the dilating gases; this is the apparatus known under the name of the *crusher*. It can be applied to any point of a cannon after they have bored a hole there, and can even be fixed to the back of the projectile. From 1869 to 1871 the English commission upon explosive substances made numerous experiments with these two apparatuses.[2] All the pressures surpassing 5,000 atmospheres were noted. At the centre of the breech the *crusher* marked as much as 8,000 atmospheres. But in this we should see nothing but a phænomenon altogether local, an effect irregular and exceptional.

Often, indeed, the interior tube of iron or steel, forming the bore of the piece, is gradually melted by the gases at the very point where the maximum pressure has been observed, that is to say, at the bottom of the bore; and they have found erosions there of more than six centimeters.

The English commission made a comparative experiment upon a series of large-grained powders, among which, the R.L.G. (rifle large grain) powder, the grains of which, very irregular and very hard, weighed on an average 5 centigrammes; pebble-powder, with angular grains of a brilliant black colour, weighed from 2 to 5 grammes; pellet-powder, with cylindrical grains shaped like a pellet, 5 grammes; and Russian prismatic powder, each grain of which is about 40 grammes. In the body of an 8-inch gun (20 cent.) they pierced a series of canals, debouching into the bore; through these they passed electric wires, communicating with a self-registering chronograph. They thus obtained a complete image of the passage of the ball through the bore of the gun; the space gone over, the speed, and, by a very simple calculation, the pressures. Nothing could be more instructive than the curves obtained by the results of this experiment. We there see that the pressure developes itself almost instantaneously, attaining 4,960 atmospheres with R.L.G. powder at the end of one fifty-thousandth part of a second, when the projectile is scarcely displaced 1½ centimetres. For pellet powder the maximum is 2,730 atmospheres, occurring after a course of 11 centimetres; for Russian powder 3,230 atmospheres, after 15 centimetres; for pebble powder 2,420 atmospheres only, after 20 centimetres. The Russian powder acted the most slowly at the first moment. In spite of these striking differences in the manner of impulsion, the powders all alike ended by impressing a speed of 400 metres upon balls weighing 80 kilogrammes, the charge varying from 14 to 16 kilogrammes. Only the pebble powder furnished this result with the least maximum pressure, and, consequently, tried the arm less; for this reason the commission preferred this powder for the use of large artillery.

We are a long way off Rumford's 100,000 atmospheres, which still vex the imaginations of many writers on technics. If we content ourselves with estimating the initial pressure at 4,000 atmospheres, we shall still have a weight of 4,000 kilogrammes applied to every square centimetre, and the ball of a 12-cent. gun (4·8 inch) would undergo in the first moments a pressure of 450,000 kilogrammes. What is the law here that links the effect to the cause, the speed of the ball to the pressure of the gas? The speed of the ball can be directly measured, for example, with the aid of a ballistic pendulum—a heavy billet of wood which, under the shock of the projectile, departs more and more from the vertical, and the inertia of which hinders or catches the impetuosity of motion which it has to chronicle. For the last fifteen years they have substituted for this rough apparatus electric self-registers of different systems,[1] which mark the precise instants of the projectile's passage on two frame-targets formed of a network of very fine metallic wires. Some months back M. Deprez invented a still simpler way, borrowed from M. Lissajou's method; they observed the ball, fitted with a fuse, through a spy-glass attached to a vibrating tuning-fork; the luminous line seemed then to form sinuosities, the number of which depended on the quickness of the passage of the projectile. By these different methods it was found that the speed of a ball can surpass 600 metres,[2] which is almost double the speed of sound. Now in mechanics they reckon *impulsive force* as the product of half the mass by the square of the speed, the *resultant* of a force as the product of the effort by the length of way. The unit of the resultant is 1 kilogrammetre — 1 kilogramme elevated to a metre in height. The *impulsive* force of the moveable matter represents the accumulated labour of the motive force acting on it, pressing it, and pushing it, and destroying its *vis inertiæ*. Keeping to a metaphor familiar to the contemporaries of Leibnitz, it is the dead force of vivified pressures, converted into the motion of the moveable matter—the stock of energy it carries, the just measure of its power; it is its *viaticum* which can now be expended in works of industry or destruction. The impulsive force of a ball weighing 10 kilogrammes, impelled by a speed of 300 metres, is expressed by the number 46,000, the unit being the kilogrammetre: such is the energy it possesses, the measure of the efforts it can furnish. For example, if thrown vertically, it would raise itself to a height of 4,600 metres, if the resistance of the air did not stop it on the way before that limit was attained; fired against an object it will exercise efforts of penetration in proportion to its capital of energy.

The mechanical theory of heat will soon throw the light of a new day upon these problems. We know henceforth that the quantity of heat represented by one calory, if it is converted into figures, is equivalent to 425 kilogrammetres. The heat then developed by any combustion whatever can be reckoned in units of labour; thus we obtain what is termed the *potential* of the combustible. Admitting that one kilogramme of powder disengages from 600 to 700 calories, we find that powder has a potential of between 250 and 300 tonneau-metres.[3] The potential of coal is 3,000—at least ten times that of powder. These figures convey only a very inexact idea of the relative importance of the mechanical effects that can be obtained from cannon and steam-engines. To reduce them to their true value we must take into account the *outcome* of these motive powers. There is always a distance between theory and reality. The work actually

[1] The proven pressures varied between 4,900 and 12,400 atmospheres.

[2] Unfortunately the indications of these instruments are far from meriting an entire confidence; the experiments instituted at the practice grounds of Gavre have shown that they vary from one shot to another from 500 to 600 atmospheres.

[1] They employed successively the electro-ballistic apparatus of Navez, Le Boulangé, Schultz, &c.

[2] Rifled steel guns, of a calibre of 8 cent., recently made at the foundry of Nevers, imparted this speed to balls weighing 4 kilogrammes, with a charge of one-third of Bouchet's A powder.

[3] The *tonneau-metre* represents 1,000 kilogrammetres. This unit is more commodious where high ciphers are concerned. According to the new calculations due to M. Larrau, sporting powder furnishes 828 calories, war powder 760, mining powder 556, which would give respectively potentials of 338, 329, and 241 tonneau-metres.

obtained from a steam-engine is only a very feeble fraction of the work furnished by the fuel; the rest is lost in overcoming resistances, in friction, collision, escapes, absorption, and at the end of the reckoning the false costs of labour have absorbed ninety and some fractions of the whole force in question. It results from this, that the effective outcome of a machine at low-pressure is never more than 1 or 2 per cent., and the high-pressure machines, with condensation and expansion, do not furnish more than from 6 to 7 per cent. of utilized labour. Thus the 3,000 tonneau-metres of the coal is reduced in practice to 200 as the maximum; and, as in every other human enterprise, the final effect is always in a miserable disproportion to the means put under contribution. We invent, we throw the news of it in all directions; we prepare our engines—*parturiunt montes*. In regard to powder, the outcome is more advantageous; with the best guns it is a fifth, or even a fourth (from 20 to 25 per cent.), so that the utilized effect of a kilogramme of powder is as high as from 50 to 75 tonneau-metres.[1] In short, the utilized effect of coal surpasses that of powder only by three or four times; but the coal recovers all its advantages if we consider the economical worth of the two agents. A kilogramme of coal costs three centimes, and will yield as much as 200 tonneau-metres; to obtain the same effect we should have to burn at least 3 kilogrammes of powder at a value of 6 francs.

To finish this comparison between the two motive powers, it is still necessary to jot down the time they take in acquitting themselves of their duty. A distinction very important to make is that of the labour—the work, mechanical effect, and of the power, the vigour of the workmen. The kilogrammetre is the unit of labour—the mechanical unit—independently of the time employed; the *horse-power*—75 kilogrammetres per second—is the unit of power, a unit essentially economical. Another consideration is as to whether it has to be accomplished at once by a grand effort, or by patient labour in a sustained manner. An athlete, be he never so strong, is seldom as useful as a skilled workman of ordinary strength. A race horse is not worth a cart horse from a working point of view. Still the race-horse costs more to breed and nourish and train; he once affords an exceptional effort, and in a few moments expends an immense stock of accumulated force:—he is a spring let loose, an explosion of energy, as in the case of powder. You would be wrong to harness a race-horse and make him drag a waggon. In the same way the explosive agents do not appear destined to play a part in the domain of industrial motive powers, and steam will perhaps never be employed to hurl projectiles, in spite of the advantages it would seem to offer on the ground of economy. To impress on a ball of 10 kilogrammes a speed of 400 metres—that is to say, to consume 400 grammes of fuel—the expense would be 1 centime, while the charge of powder would cost 3 francs; but the difficulty is the realization of the steam-gun.

From 1792 to 1793 they manufactured in France 10,000,000 kilogrammes of war-powder. Supposing them to be consumed in the same time this would be equivalent to 600,000,000 tonneau-metres, enough to raise the grand pyramids of Egypt 80 metres high. Looking at it closer we find that the force thus expended is very much less considerable than in the air. Two years contain 60,000,000 seconds; the powder burned in this period represents only a regular labour of 10 tonneau-metres per second—scarcely 130 horse-power. All the same we must not forget that the force demanded to project balls costs much more than the force of ordinary work.

How and why are certain bodies explosive! How can we measure the latent energy contained in the depth of their substance, and who will, when the time falls due, set in order the atoms of these "giants in disguise," as a celebrated physicist termed them? The immediate cause of the explosion is the expansion of the gases which are set at liberty by the decomposition of the detonating matter which seeks an issue. The expansive power of these gases will be necessarily proportional to their mass, and to the heat disengaged in the reaction; the more abundant they are the more they will feel themselves confined in the closed space where they sprang into existence; the more the temperature is heightened the more the tension will increase. The mass of the gaseous products depends upon the chemical constitution of the explosive bodies: 1 kilogramme of powder developes 200 litres of gas; 1 kilogramme of nitro-glycerine more than 800.[2] The quantity of heat arising from the combustion represents a portion of the energies concentrated in the ingredients of the explosive mixture on the day that they were manufactured. The formation of the saltpetre, the nitro-glycerine, the gun-cotton, and the picrate of potash has demanded a certain expenditure of molecular labour from the first combinations of simple elements entering into the constitution of the body up to the definite completion of the product. To blend together the atoms of azote, of oxygen, of potash, which compose the saltpetre, the affinities must have accomplished a mechanical work, banding together, so to speak, an infinite number of small retorts, which receive their functions in the act of combustion, and yield, under the form of heat, a portion of the energy they hold in reserve. The greater the interior tension, the more violent the eruption; let a shock or spark sever the chain of these fettered atoms, and the compressed gases free themselves as impetuously as winds escaping from the cave of Æolus, and the scoria they abandon causes burning, as the lava of a volcano.

The excellent researches of M. Berthelot upon explosive substances have done very much towards enlightening this side of the question. To judge *à priori* of the power of such or such a compound, this is the way he proceeds. Passing from the chemical formula of the given matter to that of the products of the combustion which one can generally arrive at, he calculates the volume of the gases which are disengaged and the quantity which is developed by the re-action. The product of these two numbers represents up to a certain point the energy of the detonation. We are going to transcribe some of M. Berthelot's figures; the first column always represents the heat furnished by one kilogramme of the matter under consideration; the second, the volume of the disengaged gases; and the third, the product of these two quantities. For want of something better these must serve as a term of comparison for explosive substances:—

	Heat.	Volume of the Gases.	Explosive Force.
	Calories.	Litre.	
Mining powder	509	·173	88
War "	608	·225	137
Sporting "	641	·216	130
Powder with a base of nitrate of soda	764	·248	190
Powder with a base of chlorate of potash	972	·318	309
Gun-cotton	590	·801	472
Picric acid	687	·780	536
Picrate of potash	578	·585	337
Mixed with chlorate of potash: gun-cotton	1420	·484	680
Mixed with chlorate of potash: picric acid	1424	·408	582
Mixed with chlorate of potash: picrate	1422	·337	478
Nitro-glycerine	1320	·710	939

This table is very instructive. We see at first that hunting-powder is that which gives most heat, that is to say, the greatest theoretical labour; it is a quick powder; nevertheless it has no more explosive force than common powder. Mining powder, which contains much less nitre, yields also less heat and less force. We then notice that powder with a base of azotate of soda has more force than ordinary powder with a base of azotate of potash. It was advantageously employed in excavating the Suez canal; it should also be less costly; unfortunately it is slow in influencing and is very hygrometric, as regards difficulty of conservation. The powder of chlorate of potash is a powerful powder with a rapid effect; at the same time it is very inflammable and explodes with the slightest shock; the preparation of this mixture gave rise, as we saw, to some terrible accidents.[1] A very curious fact, apparent from the figures in this table, is that chlorate of potash added to the other explosive substances, have the effect of doubling the heat of combustion; in regard to energy the result is less striking, because the addition of the chlorate diminishes the volume of the disengaged gases. Nevertheless these calculations confirm the advantages that practice assigns to the new powder formed of equal weights of picrate and chlorate of potash.

Gun-cotton developes scarcely as much heat as powder; on the other hand it disengages such a vast quantity of gas that its initial energy becomes more than treble that of powder. With fire-arms you need a double charge of ordinary powder to obtain the same effect as with gun-cotton; but we have already seen that the bursting properties of this agent renders it unsuitable for the use of artillery. As to nitro-glycerine, if it were not so dangerous, it would be the ideal portable force, for it

[1] In Italy they even obtained with a charge of one-tenth of the English powder termed "diamond powder," a utilized effect of 81 t.-m.; gun-cotton has given 124 t.-m.

[2] We suppose here that the gases are brought to zero degree and to atmospheric pressure.

[1] The explosive balls, the horrible effects of which have been proved in England by experiments made upon the bodies of dead horses, and the use of which, in war, has been prohibited by an international convention, were filled with a paste made of chlorate of potash and sulphur.

burns completely, without residuum, being of itself very rich in oxygen—it developes twice as much heat as powder, three-and-a-half times more gas, and seven times more explosive energy, for an equal weight; in the same *volume* it would yield twelve times as much energy. There is only one body, according to M. Berthelot, surpassing it in theoretical power; this is protoxide of liquid azote, associated with ether and other liquefied carburets; these mixtures furnish as much as 1,400 calories, and their energy is expressed by the number 1,000. All the same, it appears difficult to obtain the instantaneous explosion of such mixtures formed of liquefied gases.

The gaseous detonating mixtures develope much more heat than the solid or liquid compounds; hydrogen and oxygen, in producing one kilogramme of water-steam, disengage 3·28 calories; the vapours of ether or benzine supply 2·400. Nevertheless, we cannot use them in practice, because the gases scarcely change their volume in combination, and consequently develope pressures relatively feeble—ten or twenty atmospheres—in spite of the high temperature of combustion. To make use of them we should first have to forcibly compress them, and then preserve them in jars hermetically sealed. Thus no expectations have been renounced on this side.

We may now ask what is the importance of the fate that the future has in store for this kind of inventions, whether in the art of war or in that of the engineer. Artillery, in the course of seven centuries, has been laboriously developed, with the view of utilizing the properties of black powder. We cannot imagine what it would have become if this development had taken, for starting point, some explosive substance, such, for example, as gun-cotton. Such as it is it has every advantage to remain, for guns of great power, using slow powders with a large grain, which allow them to obtain a wide and regular ballistic effect, with a re-action relatively feeble against the piece or the breech. Since the time when "the range of a cannon loaden with powder is a thousand and five hundred paces or thereabouts," we have increased the reach of these weapons tenfold; guns are now made to carry ten kilometres, and further. The weight of the projectiles for the heaviest calibres of the navy is truly respectable; the 32-centimetre guns recently adopted by the French navy weigh 35 tons, and throw balls of 350 kilogrammes; the projectile of the monster cannon of Krupp weighs 500, and they can, with a proper charge, impress upon these enormous masses a speed of from 300 to 400 metres. The armour of war-ships cannot resist such methods of attack. Walls 780 centimetres thick of oak, covered with forged iron plates of a thickness of 15 centimetres, would be pierced for a distance of 10 kilometres by a cannon-ball of 32 centimetres, and at 500 metres the ball would pierce plates of 35 centimetres thick. Unfortunately, in the measure that they increase the range and effects of penetration they are obliged also to increase the resistance and, consequently, the weight of the guns; those of the heaviest calibre have ceased to be portable, and serve only for the defence of the coasts or for fixed positions in war; finally, the cost of each shot becomes excessive; there is a limit at which they must needs stop. There is no question here of increasing the force of an explosive agent, but we would try to obtain a less costly powder. Things have a different face, however, when we reflect that the employment of ironclads will completely alter naval tactics, and that we shall have to come back again to the principle of fire-ships, in substituting for a broadside of cannon-balls torpedo buildings and small boats armed with explosive cones and destructive engines, which will attack the enemy by blowing her up, while the vain demonstration of wasted projectiles would, as has been said, "make no one tremble but the Minister of Finance." For such purposes dynamite and its kindred substances will, perhaps, take a capital importance. It will be the same in the domain of civil engineering, where these formidable means of action which can displace rocks and heave up every obstacle, promise such economies of time and labour as were scarcely dreamed of formerly.

[We now quote an article on the "Definition of Explosive Force," which the author, M. Radau, has kindly forwarded to us. This *définition* appearing in the September number of the "Moniteur Scientifique" is, in some sort, a rider to M. Papillon's study.—H.C.]

On the Definition of Explosive Force.

By M. Radau.

The relative force of explosive matters can be measured in different ways. We can first consider, then, *potential* Π, that is to say, the combustion heat of 1 kilogramme, valued in labour, to which it is proper to add the potential *at zero* π, or the heat that the substance in question contains at zero degree (at the *absolute* temperature of 273°). We obtain π in calories by multiplying 273 by the specific heat; to express it in tonneau-metres, it must be again multiplied by ·425. Adopting the statements of M. Berthelot, we thus find :—

	Heat disengaged.	π		Π	
	Calories.	Calories.	Tonneau-metres.	Calories.	Tonneau-metres.
Mining powder	510	50	21	560	238
War „	608	50	21	658	280
Sporting „	641	50	21	691	294
Gun-cotton	590	56	24	646	274
Nitro-glycerine	1,320	56	24	1,376	584

The values of π are only somewhat uncertain approximations. The potential Π represents, so to speak, the capital of labour that each substance can expend, and we see that the potential of nitro-glycerine is double that of the other matters considered; but in reality a fraction only of this capital is transformed into mechanical effect.

When there is a question of producing effects of rupture, it is essential to consider the initial tension of the disengaged gases by the combustion of the explosive substance in a capacity equal to its volume. Supposing Mariotte's law to remain applicable to these high temperatures, and that we could neglect the phenomenon of dissociation, the initial tension might be calculated as follows :—It is at first proportional to the binomial of dilation (which may be represented by $\Pi : \pi$), then to the volume G of the gases, reduced to zero and to 760 millimetres; lastly it is in inverse ratio to the capacity k, when the gases form, which depends on the density of the explosive matter, and also on the residue it leaves. In the powder we admit that the residue of 1 kilogramme occupies 0·4 and the gases 0·6. Gun-cotton, whose density is only one-third that of powder, takes much more room; in admitting that the gases of 1 kilogramme of gun-cotton occupy at first a capacity of 3 litres, we find that their tension is much feebler than we could have supposed. Here are a few calculations obtained in this manner, that is to say, in forming the ratio $\frac{\Pi G}{\pi k}$:—

	G	ΠG	k	Tension.
	Litres.			Atmospheres.
Mining powder . . .	173	412	0·6	3,200
War „ . . .	225	630	0·6	5,000
Sporting „ . . .	216	635	0·6	5,000
Powder with excess of nitre.	205	630	0·6	5,000
Gun-cotton	801	2,195	3·0	3,100
Nitro-glycerine . . .	710	4,146	0·6	29,000

In the product Π G we have suppressed two zeros; it corresponds to the volume G by the heat disengaged that M. Berthelot takes for his term of comparison; but we see that it is not at all in ratio with the initial tension.

It is, then, necessary to consider the labour utilized as 1 kilogramme of explosive substance furnished to a gun, and to obtain it we must calculate the outcome. The *outcome*, that is to say, the fraction of the freed labour that is utilized, depends on the way in which the detention of the gases has been managed, and the speed with which the powder burns goes for much. The experiments of the English commission show that the pressures are developed very briskly with quick powder, and gradually with slow powder. To put these very complicated effects in a clear light, we should have recourse to the graphic method. We can nevertheless form an approximate idea of the effects they produce by supposing that the combustion takes place instantaneously. In this case the outcome may be expressed by the binomial $(1 - w^x)$, where w is the ratio of the initial and final volumes and $x = \frac{G}{\pi}$, if we distinguish by G the number of litres furnished by 10 grammes of the explosive substance (by dividing by 100 the values of G given higher up). For a gun of 12 cent. the length of which is two metres, and the charge elongated, we can adopt $w = \frac{1}{10}$, and in taking $x = 0{\cdot}09$ for the powder, we find an outcome of 24 per cent. With $w = \frac{1}{10}$ and $\frac{1}{30}$, we shall have respectively 19 and 26 per cent. The maximum outcome of the best cannon is, in effect, about 25 per cent.

If the charges of powder, of gun-cotton, of nitro-glycerine, are determined so that the initial volume of the gases k shall be almost the same (which supposes a relatively feeble charge of gun-cotton), we can everywhere take $w = \frac{1}{10}$, and then we have

	x	Outcome.	Π	Utilized Labour.	
Powder . . .	0·09	0·24	280	67	tonneau-metres.
Gun-cotton . .	0·33	0·63	274	172	
Nitro-glycerine.	0·30	0·59	584	343	

The utilized labour of a charge of powder of 1 kilogramme is, in effect, an average of from 60 to 70 tonneau-metres. For gun-cotton, experiments have given 124 tonneau-metres; this figure answers to $w = \frac{1}{7}$.

The results we have indicated here are, it must be well understood, only approximative, destined to give an idea of the phenomena. Numerical data are wanted for more precise calculations.

[We make our next abstract from a volume of the admirable "Actualités Scientifiques" series, all of which are edited and published by the Abbé Moigno. Each volume of this series, at a price varying from one franc and a-half to two francs, contains the latest contributions of the most eminent authorities upon any scientific subject under discussion, excellently collected and resumed by the editor. We have nothing like this in England, nor as yet have we that popularly diffused taste for science which alone could render such a collection feasible.

The "Recherches sur les Agents Explosive Modernes" contains (1) Mr. F. A. Abel's lecture, which is too well known to need comment; (2) M. Bertholet's memoir, which has been quoted and discussed in M. Papillon's foregoing article; (3) the detailed experiments of MM. Bache and Brüll, which M. Papillon has also exhausted; (4) "Résumé des Travaux sur la Dynamite et ses Applications," by M. J. B. Viollet. This we now translate and condense.—H. C.]

I.—The Preparation of Dynamite.

Dynamite being nothing but a mixture of nitro-glycerine with a siliceous body, it will be sufficient to indicate the way in which the first of these substances is manufactured, and for this purpose we must borrow from the pamphlet of M. Champion, who, while repeating the description given by M. Payen in his "Chimie Industrielle," has thought fit to add many details as to the phases of operation, and as to the means of avoiding all risk.

A mixture is made of 2,200 grammes of sulphuric acid at 66°, and of 1,100 grammes of azotic acid, steaming (to one equivalent of water); the temperature rises notably. When the mixture has cooled, which is artificially obtained in a very short time by means of a current of water, the liquid is portioned off into jars and pitchers of glass or earthenware holding about 150 or 200 cubic cents.; then 500 grammes of nitro-glycerine are broken, so that they can introduce into each jar a quantity proportionate to the weight of the acids which it contains. This addition should be slowly made while the recipient liquid is stirred, and the cooling by means of a water current continued. If the glycerine be introduced too rapidly, or if care be not taken to properly cool the recipient liquid, the mixture becomes gradually heated, yellow vapours of hypoazotic acid appear, and a violent re-action sets in, forcing the liquid out of the jar. In this case it is the best plan to throw the whole into the water at once. This re-action arises from the action of the azotic acid upon the glycerine, and the heat produced by the mixture of the sulphuric acid with the water it contains. The glycerine is generally delivered at 27° to 28° Beaumé. The re-action then will be as much less violent in proportion as the glycerine is more anhydrated; they should, therefore, in preference, employ it at 30° or 32°.

The 500 grammes of glycerine can be directly introduced into the mixture of the two acids without the operation of breaking; but in this case it is necessary to act with prudence, and to assure ourselves often that the temperature does not rise. Nevertheless, experience shows that the first method is preferable, especially when the regular apparatus is not used.

At the end of ten minutes they pour the liquid into a large quantity of cold water, and, by stirring, the nitro-glycerine produced is precipitated under the form of a whitish oily liquid, which gathers together rapidly at the bottom of the receiving vessel; the water is poured off and renewed and the liquid again stirred; and this is continued until the product is no longer acid. To obtain this result, it is necessary to shake vigorously while enclosing the liquid in jars or pitchers; without this, the laving water should remain neuter, while the nitro-glycerine would be still acid, which would hasten its decomposition, and cause it to lose in a few weeks a portion of its properties.

The manufacture of nitro-glycerine produces violent headaches among the workmen. The best way of preventing this is to work in an airy place, or in the open air itself; probably a few aspirations of ammoniacal water would in a short time overcome these ill effects.

Next, the excess of water is carried off by means of a tapped funnel. The nitro-glycerine under these conditions is milky, on account of the particles of water it holds in suspension, but can be rendered limpid by the addition of melted hydrochlorate; but this operation is useless for the manufacture of dynamite, and would present many inconveniences caused by the heating required to produce it. The nitro-glycerine freed from water has the appearance of a liquid, colourless oil, the density of which is 1·6. At the contact of an inflamed body it burns slowly with a green flame, and detonates under a violent shock.

Thrown out upon a heated metal plate it becomes volatile, without exploding, at a temperature beneath dull red-heat; at a dull red-heat it detonates violently, as if by a shock, and above that heat takes a spheroidal condition, and decomposes without explosion in becoming volatile.

On account of the danger it presents, it is important to transform the nitro-glycerine into dynamite, this latter product offering great conditions of safety.

A large number of matters have been proposed as mixtures to obtain dynamite. They employ desiccated silica, derived from porcelain clay, submitted to the action of sulphuric acid in the manufacture of alum; but often the porcelain clay has been imperfectly submitted to the action, and the product obtained is not suitable for the required purpose.

Sand and finely-powdered loam-earth can be also utilized for the same object. In Germany crushed limestone is used. "As to us," says M. Champion, "we prefer the burnt earthenware, coming from the glass-furnace or the brick-kilns. This substance gives us excellent results; its porousness allows us with an equal weight to obtain a much drier product. In short, any non-plastic, siliceous bodies may be used for the mixture, especially if they are porous."

In operating, the siliceous powder (80 or 75 per cent.) is placed in an earthenware or porcelain jar, and on this is poured from 20 to 25 per cent. of nitro-glycerine; then the whole is stirred with a wooden spud. As a precaution, and also to obtain the product in a homogeneous state, only some few kilogrammes are prepared at one time. When the mixture is intimately blended the dynamite is ready for use; the sides of the jar in which it is placed ought not to be moistened. We may judge of the harmlessness of this body by placing a pinch of it on an anvil, and striking it with an iron mallet; at each blow we hear nothing but a feeble sound, something like the cracking of a whip.

It is indispensable that the siliceous matter should be employed in the state of fine powder, for a mixture of nitro-glycerine and river sand detonates by the shock, as nitro-glycerine itself does under the blow of the mallet.

Return of the Expenses of a Manufactory making 50 kilogrammes of Dynamite a day.

	fr.
10 kilos. of glycerine at 30° or 32° B. at 150 f. the 100 kilos.	15
14 kilos. of sulphuric acid at 66° at 20 f. the 100 kilos.	8 80
22 kilos. of azotic acid at 110 f. the 100 kilos.	24 20
40 kilos. of pulverized loam-earth at 5 f. the 100 kilos.	2
The wages of three workmen	18 20
Management	10 0
General expenses, &c.	21 80
Total	100 francs

That is, two francs per kilogramme for dynamite containing 25 per cent. of nitro-glycerine. If the manufacture is continuous, and on a large scale, they are able to turn out this product at a cost varying from 1fr. 60 to 1fr. 80.

Transformed into dynamite, the nitro-glycerine is preserved for a long time, and does not separate itself from the siliceous matter with which it has been mixed.

II.—Experiments upon the Effects of Dynamite fired by Capsules of Fulminate of Mercury.[1]

On Blasting Rocks.—In the quarry of Dæniken (hard calcareous Jura limestone) they pierced a blasting-hole close to the vertical wall of the rock; the hole, also vertical, was 1 m. 11 deep, and 0 m. 03 in diameter. This hole was 2 m. 70 distant from the vertical wall of the rock; the cartridge was 2·5, and the hole was, as usual, completely filled with water. The stone was shattered by the explosion into almost the form of a pyramid. The blown-out matter was projected some distance, and measured 6·5 cubic meters. The effect would have evidently been more considerable if the width of the hole had been less, relatively to its depth.

[1] These experiments were contributed by MM. Boiley, Pestalozzi and Kundt.

In a second trial the blasting hole was 1 m. 32 deep, 0 m. 03 in diameter; the charge, cartridge 3·5, occupied in all 0 m. 12 in height; and the hole, as before, was filled with water.

The stone was blasted as far as three metres in depth, and the *débris* represented a volume of about 71 cubic metres.

Blasting Isolated Stones.—On a block of Saint-Gothard granite, measuring a little less than 1 cubic metre, they bored a hole about 0 m. ·20 deep, which they half filled with dynamite. The explosion reduced the block into a great number of little fragments, which were scattered for some distance on all sides.

In a solid block of calcarean stone 0 m. 96 long, 0 m. 66 high, and 0 m. 90 broad, they bored a cavity in the form of a mortice, from 0m. 15 long by 0m. 12 deep, and 0m. 02 broad. Here they placed a cartridge of dynamite in the direction of the length, and then filled the hole with clay.

The explosion broke it into three large pieces, and into a great number of smaller splinters.

Explosions in Cast-iron.—They first operated upon a very massive and homogeneous cast-iron cylinder of first-rate quality, the weight of which approached 2,500 kilogrammes. In it they bored two holes of 0 m. 0215 diameter, the first 0 m. 320 deep, the second 0 m. 300. The charge of dynamite for the first was 0 m. 090, for the second 0 m. 200 high; both were filled with water. The two holes were fitted with matches, but only that belonging to the first was lit, and thus there was only one explosion.

The cylinder was burst into three pieces, one of which, weighing some 600 kilogrammes, was projected a distance of 6 metres.

They then fired the charge in the second hole. Two fragments were thrown about 6 metres distance each, and the remains of the block, by the effect of the recoil, was driven deeply into the earth. On looking at the *débris* they perceived that the diameter of the holes at their base had expanded to 0 m. 032, being consequently enlarged by 0 m. 0105.

A second massive cylinder of cast-iron 0 m. 84 long by 0 m. 25 deep, was bored in the middle by a hole 0 m. 195 deep and and 0 m. 024 in diameter. They filled this hole with dynamite to the height of 0 m. 075, and with water up to the orifice. The explosion blew out the water and produced only a few cracks in the cylinder. They then fired a second charge, like the first, which divided the piece into two considerable portions and several small fragments. The hole was again enlarged at the base, attaining 0 m. 035 diameter, its depth being increased by 0 m. 005.

Explosion in Malleable Iron.—A huge anvil, weighing about 200 kilogrammes, was bored with a hole 0 m. 180 deep and 0 m. 215 in diameter. The charge was 0 m. 060 high, the rest being filled with water. The explosion rent the block into two pieces.

Explosion under Water.—A cartridge fitted with a fuse and fastened to a plank was plunged into the river Aary. The explosion threw, for a considerable height into the air, a mass of water, which fell down again in rain over an extended surface for several minutes.

The whole of the preceding experiments show that dynamite, in regard to its explosive effects, is much superior to blasting powder and other analogous compounds, and that its strength can only be compared to that of nitro-glycerine. The general introduction of dynamite into all quarry-work, in mining exploitations and the boring of tunnels, will be then a considerable step in progress, as far as regards both the saving of time and the saving of money.

TAYLOR'S AMERICAN FIELD-PIECE.[1]

FIRST successfully employed during our late war, and more recently in the struggle between France and Prussia, the battery gun, like the submarine torpedo, may be safely predicted as designed to exert no small influence in the determination of future conflicts. Even in the crude forms in which, as necessity demanded, it has been hurried to the field, its terrible execution has proved it a most formidable and deadly arm: and as in late years improvements have been made in its construction, all tending to increase its power, the fact has become more clearly apparent that the mitrailleuse forms still another link in that chain of weapons of human destruction, which, beginning with the bow of the savage, the world believed forged and complete when the needle-gun at Sadowa brought to a sudden ending a short though bloody war.

With the general principles upon which the construction of the battery gun is based, we presume our readers to be reasonably familiar; so that, in illustrating the new mitrailleuse of Mr. Taylor, description of the minor details will be dispensed with. A short brass cylinder, containing twenty-four barrels, together with a quantity of machinery, is mounted on an ordinary gun carriage. Such is the general appearance of the invention. The length of the piece is about twenty-eight inches, and its weight, with its appurtenances, is nearly a thousand pounds. We begin our description with the loading mechanism. A is a magazine consisting of twenty-four tubes, each of which contains nine cartridges of size suitable to the calibre of the barrels. The tubes are confined between heads. The entire receptacle can be instantly removed from its position when its charge of ammunition is exhausted, and another similar filled magazine substituted, so that the gun may be thus kept almost continually supplied with cartridges. A suitable number of these charged reservoirs are designed to be carried in the ordinary caisson. At B is a cylindrical case, which encloses the feeding apparatus, consisting of twenty-four steel rods, which are intermittently moved forward into the magazine tubes through the medium of the rack shown above the casing, actuated by suitable mechanism in connection with the lever D. At each movement of the rods one cartridge is forced out of every magazine tube, and into corresponding cavities in a rotating chamber plate, a portion of which is shown projecting at C. This plate consists of four wings, and revolves in the slotted breech-piece into which the barrels are screwed. In each wing are twenty-four cartridge chambers circularly arranged. Of course all four wings or sets of chambers are on the same plane, and rotate on a common axis, so that one after the other, as each is charged from the magazine, is revolved so as to come into exact line with the barrels of the piece.

The same lever, D, that actuates the feeding apparatus, also communicates motion to the volley firing plunger or piston E. F is a movable latch fixed longitudinally upon the top of the latter, holding it out of action when a fusillade discharge is desired. The details of the mechanism which explodes the cartridges are necessarily unrepresented in our engraving. We need, in reference thereto, only allude to a number of spring spindles which are either simultaneously thrown against all the cartridges, in the wing that is in position, by the piston E, or which are caused to strike their corresponding cartridges separately by means of a cam arrangement, within the breech and rotated by the steel crank G. The first system causes a volley; the second, a fusillade.

When firing on the latter plan, as soon as each wing of the chamber plate is exhausted, a spring catch H automatically stops further rotation of the crank until another filled wing is revolved into position by the lever D. Between the wings are arranged brushes and sponges which, in passing, clean the rear of the barrels between the discharges.

The lever D performs three offices: it works the feeding apparatus, rotates the wings, and operates the shell ejector. This last mentioned apparatus is contained in the case I. The movement of the lever which brings up a filled wing necessarily turns away the one that has just been fired, and which still contains the empty cartridge shells. The cylinder I, however, is so situated as to be exactly in the path of the discharged chambers, and besides other mechanism encloses twenty-four rods, which, as above intimated, by the action of the lever D are caused to enter the chambers and push out the discharged shells, which fall to the ground.

The arrangement of the barrels is clearly indicated in the gun to the left of the engraving. It will be noted that their muzzles are placed in the form of an ellipse, while at the breech they are circularly disposed, the object of the former configuration being to give a wider dispersion to the balls. J is the water casing, into which water may be introduced through the orifice K, and the barrels thus continually kept cool. But three men are necessary to operate the piece, one at the crank and lever to fire, another at the rear to point, and a third to renew the magazines; and it will be remarked that all vulnerable portions are carefully so placed as to be out of danger from damage by rifle shots from the front.

At Sand's Point, L. I., a series of interesting experiments were made by the inventor, which proved quite satisfactory. At a range of 100 yards the target was pierced by a broadside which described an elongated horizontal ellipse, 2 ft. wide at centre and 12 ft. long. At a range of 200 yards the width of this ellipse remained nearly the same, but the length increased in the same proportion as the increase of range. This was repeated, both by broadside and fusillade, a great number of times, the effect being uniform throughout the experiments. The piece was discharged several times over the waters of Long Island Sound, and the effect was quite interesting. A volley or broadside of shot striking the water 1,200 yards away produced a noise like that of beating the surface with the flat side of a board, the projectiles

[1] From the "Scientific American."

TAYLOR'S AMERICAN FIELD-PIECE.

covering a line of about 144 ft. The effects of the fusillade were equally curious. The missiles would fall in quick succession, producing the same sharp sound, and for more than a second after ceasing fire this would continue, so that a charged wing could be brought up to the lever, the shells ejected, and the fire reopened by the time the last missile of the previous charge had struck. The inventor concludes that, virtually, a continuous and unceasing stream of bullets may be kept up by the crank fire for any desired length of time.

To Mr. J. P. Taylor, of Tennessee, is due the credit of this very ingenious weapon, of the successful operation of which we have assured ourselves by personal observation. In the experimental battery, an excellent piece of mechanical work from the shops of the Holske Machine works in this city, from which our engravings were made, we remarked but few points that were susceptible of simplification, and we could suggest nothing which had not been anticipated by the inventor and fully provided for in a second gun which we learn he is about to construct. The piece has already attracted no small degree of attention in military circles, and we do not doubt but that it will excite even a greater interest when its merits are more fully known to a wider public. Further and more detailed particulars may be obtained by addressing J. P. Taylor, patentee, or D. Hockett, attorney, Knoxville, Tenn.

THE LIGHT PETROLEUM OILS;

CONSIDERED AS TO THEIR SAFETY OR DANGER, IN VARIOUS DOMESTIC USES.

(*A Report to the Committee of the Franklin Institute, to inquire into the causes of conflagrations and the most efficient methods for their prevention.*)

GENTLEMEN:—In the field of illumination for public and domestic purposes, the direction of invention has been for some time confined, not so much to the problem of creating new systems, as to the improvement of those already extant. Indeed, to one who fully appreciates the comprehensive advantages which coal-gas possesses for illuminating purposes, both æsthetically and sanitarily considered, and the elaborate conveniences which have been devised and so universally introduced, to render the details of its distribution and consumption perfectly automatic, while at the same time perfectly under control, the difficulties to be overcome by an innovator upon a field so thoroughly cultivated, will be comprehended.

Financial considerations, however, preclude the establishment of gas-works in locations other than large cities and towns—and for the benefit of those who are deprived of the luxury of coal-gas, inventors have most zealously striven. The development of the petroleum industry afforded a most effective spur to inventive genius, and has called forth a multitude of plans and processes for accomplishing this very necessary object. Of some of these it is the object of the writer, in the course of this report, to discuss the merits, as well as their bearing upon the score of safety. The composition and character of the petroleum oils are noteworthy, and the writer may hope to be pardoned for dwelling perhaps at too great length upon this point, since, otherwise, those who may not be conversant with the subject, will fail to comprehend the accuracy of any inferences which may be based upon them.

They are all of them composed of the elements carbon and hydrogen, and range, by imperceptible steps, from oils which are exceedingly light and inflammable to those which are heavy, thick, and viscous, and which can only be ignited at an elevated temperature. Nor is the material obtained from a certain locality to be regarded as a simple oil, since it is invariably a mixture of readily and difficultly inflammable oils. There is, of course, much difference in the appearance of the materials obtained from different locations—a fact most palpably manifested in their difference in gravity—but their general character is the same, whether found upon the shores of the Caspian Sea or in Pennsylvania. So numerous are the constituents of these oils, so closely do they resemble each other in their physical and chemical properties, that their separation and identification has afforded a problem which the skill of the chemist has thus far been baffled to solve; and the sum of our knowledge of them may be contained in the statement, that they consist of mechanical mixtures of a great number of miscible hydro-carbons, whose gravities and boiling points increase by such imperceptible gradations that it is impossible to separate them, except roughly. For convenience sake, a number of commercial distinctions have been made, to which there is, at the present time, no valid reason to object. Of these, those which are known familiarly under the names burning oil or kerosene, benzine, and gasolene, alone concern the purpose of this paper.

Petroleum, according to Mr. S. Dana Hayes, State Chemist of Massachusetts, yields, by distillation, nine distinct products, as follows:—

Name.	Sp. grav. (Water, 1).	Sp. grav. Beaumé.	Boiling point.
Rhigolene . . .	·625	—	65° Fahr.
Gasolene . . .	·665	85	120° „
C. Naphtha . . .	·706	70	180° „
B. Naphtha . . .	·724	67	220° „
A. Naphtha . . .	·742	65	300° „
Kerosene Oil . .	·804	45	350° „
Mineral Sperm Oil .	·847	36	425° „
Neutral Lubricating Oil	·883	29	575° „
Paraffine . . .	·848 (?)	—	

It must, however, be remarked, that the above figures express only the properties of the several products when obtained in as homogeneous a condition as it is possible to manufacture them commercially; and though under such circumstances the specific gravity of the oil affords a fair exponent of its inflammability, there can be no greater error than to trust to this as an infallible indicator of the quality of oils sold for household purposes.

Since this assertion may require explanation, it may be well to state that, owing to the perfect miscibility of all the petroleum products, it is possible, by simply mixing a light and a heavy product, to obtain an oil having a specific gravity ranging anywhere between the gravity of the two extremes of which it is composed. The temperature, however, at which such a mixture would evolve an inflammable vapour, and that at which it would ignite, would be very materially affected; for such a mixture would not serve to neutralize the volatile qualities of the lighter oil.

An oil tested with the hydrometer might, for example, show a gravity of 45·13°, but, instead of being a comparatively homogeneous oil, might be composed of a mixture of oils lighter and heavier, of which the indicated gravity simply showed the mean value. What is more important, however, such a mixture, instead of requiring a somewhat elevated temperature (about 120° F.), to evolve an inflammable vapour, as would be the case with a nearly homogeneous oil of this gravity, might ignite at all ordinary temperatures.

In regard to the inflammability of the petroleum products, two indications have been fixed, by which this quality may be conveniently estimated, and which at the same time afford the *only sure* indication of the safe or dangerous character of any of these products. These standards are called respectively the flashing and burning point. The first is the temperature at which the sample evolves an inflammable vapour; the second is that at which the oil itself ignites.

It will be evident, from what has been said, that we have here an infallible means of determining that which the hydrometer fails to indicate; namely, whether a sample of oil is a mixture, or is comparatively homogeneous.

Subjected to the first test, the lighter portions of the oil will successively rise to the surface, will be there converted into vapour, which, when evolved in appreciable quantity, will ignite with a succession of flashes on the approach of a lighted body.

If the sample is mainly composed of a heavy oil (whose boiling point is therefore high), this succession of flashes will be the only phenomenon at first observed; for the heat evolved from the momentary ignition of the lighter vapours given off, will not be sufficient to start the ignition of the whole body of oil. The temperature at which this phenomenon is first observed, is called the flashing point.

If the heating of the sample is continued, a temperature will soon be reached at which the remaining heavy constituent begins to evolve its vapours, which, when sufficiently rapid, will, upon being ignited, inflame the body of the oil itself. This temperature is called the burning point. By this test alone is it possible to determine the character of these miscible oils; and so certain are the indications which it affords, that in the several legal enactments with which it has been found necessary to surround the traffic in these oils, it has been relied upon to correctly indicate their quality.

In the preceding illustration, it appeared that the addition of a small quantity of light oil to a heavy one acted in such a way as

to noticeably lower its flashing point. This action grows more marked as the amount of the adulteration increases, and will, when a very moderate dilution has been reached, also seriously affect the burning point of the mixture, the lighter portion of the sample being readily inflamed from the flash of the greatly increased volume of vapour which it throws off.

Dr. D. B. White, President of the Board of Health of New Orleans, found, for example, in experimenting with an oil which flashed at 113° Fahr., that an addition of

One per cent. of naphtha caused it to flash at				103°	Fahr.
Two	"	"	"	92°	"
Five	"	"	"	85°	"
Ten	"	"	"	59°	"
Twenty	"	"	"	40°	"

After the addition of twenty per cent., the oil burned at 50.°

It must be noticed that, though in general character the petroleum compounds are almost identical, yet, when considered in relation to their adaptability as illuminants, a marked distinction can be made.

The heavy oil boils at an elevated temperature, and at the ordinary temperature throws off only an inappreciable quantity of vapour. A lighted match, approached to an open vessel containing it, will not ignite it, and if plunged into the oil, it will be extinguished. With the other members of the series, however, the boiling point is but a trifle removed from the ordinary temperature; and at the ordinary warmth of our dwellings, they are constantly throwing off volumes of vapour (the gasolene, of course, to a much greater extent than the naphtha). A lighted match approached to an open vessel of either of them, will ignite them at once, and at some distance from the surface of the material.

It appears, therefore, that the light oils, owing to their extreme volatility, cannot be handled with the same indifference as the heavy ones. An open vessel, containing either of them, placed at some distance from the neighbourhood of a flame, may, more likely than not, be the cause of sad mischief, and from a very simple cause. The vapour which it is constantly and imperceptibly giving off, flows from it in all directions, seeking the floor, in virtue of its superior density to the air—and once in contact with the flame—a flash—and the ignition darts, in an instant, back to its source.

Of the insidious, imperceptible nature of the dangers attendant upon their employment as illuminants, the public cannot be too clearly conscious, or too forcibly warned. And under no circumstances is the employment of these incendiary materials so severely to be condemned, as in the portable lamp so generally employed in the household. There are, it is true, circumstances under which they may be, with certain precautions, employed for other purposes than as lighting agents—and of these the writer will have occasion to speak further on—but, in the portable lamp, they may at any moment add another to the list of terrible accidents with which the public is already too familiar. Let the attention be but for a moment directed to the state of things involved. The body of the lamp is invariably of glass, and hence fragile. It is supposed to contain some of one of the lighter oils, the peculiar properties of which have just been alluded to. In the process of burning, the metallic attachments of the lamp will communicate sufficient heat to the body of the oil within, to fill the whole of the space above the oil with its vapour. So long, now, as the lamp remains unbroken, and its attachments without leakage, this circumstance is of little consequence, as, of itself, the confined vapour cannot be made to explode or ignite. But suppose the lamp, in this condition of things, to be shattered by a fall—a circumstance by no means infrequent—the consequence will inevitably be that the inflammable vapour in the neighbourhood of the flame would at once ignite, and with it the whole body of oil in the lamp, to the imminent peril of person and property. Or suppose the equally probable circumstance, that the lamp, as before, should be refilled while burning, when the result might be, if possible, more disastrous than in the preceding case; for the volatile and inflammable vapours filling the upper portion of the lamp would inevitably, by their rapid diffusion into the air immediately surrounding the flame, form an explosive mixture, from the effect of which the lamp and its burning contents would be scattered in all directions. Where the oil made use of is one of proper quality, neither of the accidents here hypothetically stated would be possible, since, in no case, with a properly constructed lamp, could there be generated within the body of the lamp an amount of vapour sufficient to cause an explosion; nor could the oil itself be ignited at so moderate a temperature.

It is simply to be set down to good fortune, if one who has employed these oils for household purposes has escaped scot free, since no amount of care can avail against the inevitable result which must follow one accident. It is easy to understand how persons ignorant of the highly dangerous character of the light petroleums may unknowingly make use of them in the manner above named; but it is really a matter of concern and surprise that so many, even of those who are thoroughly aware of the nature of the incendiary they are introducing into their households, are, nevertheless, thoughtless or indifferent enough to continue the suicidal practice—for no term can be too strong to properly characterize the fearful nature of the risk one is constantly running while employing these oils in the household.

There is, unfortunately, such a thing as too much legislation, as most communities are unfortunately aware, but there would seem to be no grounds for such a complaint on a subject which so intimately concerns the safety of the individual and the general public, as just this one. There are, it is true, laws which are intended to regulate the sale of this material, an inspection of its quality, and severe penalties, on paper, designed to punish those who sell, for illuminating purposes, an oil which will inflame below a temperature fixed by law at 110° Fahrenheit. But, most unfortunately, the legislation on the subject utterly fails to accomplish the end for which it was intended, namely, to protect the great body of the people, who are not supposed to be familiar with the nature of these materials, from the possibility of unknowingly running into such dangers as those which the writer has endeavoured to make clear in what has preceded. And this lamentable state of affairs is due to the fact that the powers of the Inspector are limited to the examination of oils which are sold as refined petroleum, thus placing the host of dangerous patented compounds now flooding the market beyond his control—and from the fact also that the inspection is made *before* the oil leaves the hands of the wholesale dealer, and not after it has passed into the hands of the retailer, where it commonly is adulterated with a fair proportion of benzoine. The temptation to this reckless practice is to be found in the fact that the benzoine or naphtha is considerably cheaper than the kerosene; and to this fact, as much as to the first named evasion, and insufficiency of the laws on this subject, is to be ascribed the host of misfortunes, which of late have multiplied with such alarming frequency as to horrify our public into serious consideration of the dangers they were unconsciously running.

An average crude oil contains :—

	Per cent.	Price per gallon wholesale.	Price per gallon retail.
Cymogene } Rhigolene, }	2	$1·50.	
Gasolene,	1·5	48 to 35 cents.	
Naphtha,	10	5 to 7 cents.	12 to 20 cents.
Benzoine,	4	12 to 16 cents.	16 to 20 cents.
Kerosene,	55	20 to 25 cents.	30 to 40 cents.
Paraffin,	19·5	14 to 18 cents.	

Of these products, a very considerable proportion (about 15 per cent., as shown by the table) consists of the benzoine or naphtha, and for this the demand in the various industrial arts is by no means equal to the supply; in consequence of which it commands but an inferior price in the market; in fact, considerably less than that demanded for the burning oils proper. Here, then, exists a direct temptation to dishonest or ignorant manufacturers and dealers to adulterate their stock of burning oil with oils of inferior price and dangerous quality. To what extent this reckless practice is carried on, the community have no just conception, but the writer feels safe in asserting that it is as general as any of the trade adulterations. The assertion is based upon the results of a large number of examinations into the character of oils from various portions of Philadelphia, sold to the public as burning oils; an examination which revealed the startling fact that, of a number of samples thus tested, only a trifling percentage of the whole number passed the ordeal of the fire test. In other words, the oils were, with the very few exceptions indicated above, simply burning oils, more or less liberally adulterated with benzoine. How far these facts will go to explain the too often repeated instances of "coal-oil horrors," the intelligent reader will be able to judge for himself. And it is certainly a melancholy species of consolation to know that what has been here shown to be true of Philadelphia, is true, also, of other large cities and towns. As an indication of the condition of things existing elsewhere, the writer would refer to the recently published annual reports of the fire inspectors of neighbouring cities, in which attention is called, in most earnest terms, to the unusually large proportion of fires, accompanied, at times, with loss of life, during the year just passed, which were ascribable to petroleum; tracing them directly to an utter disregard for and inadequacy of the laws designed to protect the public against the danger of employing the light oils for household purposes.

From a recently published tabulation by the Fire Marshal of the city of Baltimore, it appears that out of 63 samples of oils,

collected from various quarters of that city, but eight, or less than 13 per cent. of the whole number, were found to stand the fire-test; and, as the laws regulating the traffic in these products have suffered no material modification since its publication, it is fair to conclude that this statement represents the average quality of the oils sold in that city to-day, if, indeed, an investigation should not show a yet lower per-centage.

The writer regrets that it is not in his power to add to the above the results obtained by Prof. Chandler in his recent report to the Board of Health of the city of New York, a report replete with valuable information upon this subject, since that portion of the report relative to this item has not yet appeared in available form; but, from the tenor of the portion already made public, there can be no doubt that the results of his examination into the quality of the New York oils will strengthen that above-quoted.

The following table gives the results of the examination made by the writer, in connection with Dr. T. R. Wolf, of Delaware College, of a number of samples of oils furnished by Dr. J. B. Burleigh, Chairman of your Committee, as having been obtained from various dealers, wholesale and retail, in this city and its neighbourhood, and which may therefore be fairly considered to represent the average quality of the oils our citizens are using in their households:—

No. of Sample.	Spec. Grav. Beaumé.	Flashing Point. Fahr.	Burning Point. Fahr.
1	46°	84°	86°
2	46·5	74	86
3	65	54	54
4	66	51	51
5	64	55	55
6	48	117	120
7	64	54	54
8	45	74	86
9	64	54	54
10	70	51	51
11	46	89	100
12	48	64	75
13	46	93	100
14	63	52	52
15	70	54	54
16	70	54	54
17	48	55	61
18	63·5	52	52
19	64	52	52
20	46	97	106
21	64	54	54
22	46	85	92
23	47	84	95
24	25	above 300	above 300
25	46	146	156
26	48	128	136

Most of these samples, notably Nos. 7, 9, 10 and 12, were obtained from firms who drive an extensive trade in retailing to small dealers; and establish the character of the material which is sold by the quart or pint in at least five thousand shops and stores throughout this city and its neighbourhood. These prove to be amongst the most dangerous of any of the tested samples. That, however, which adds a peculiar interest to these specimens, is the fact that they are extensively advertised as safe oils, under specious names which disguise from the public their highly dangerous character.

Taking into consideration the extensive sale of the tested samples—as well as the fact that three of the four which were found to pass the government standard (Nos. 24, 25 and 26) were head light oils, which are rarely used in the household, but are mainly confined to railway use, lanterns, &c.—the proportion of safe oils really in common use by this public is so small as to be worthy of the gravest consideration. Including the oils just excepted, the proportion of safe oils used in our midst would be practically about one-twelfth of 1 per cent. An examination of the ten oil samples sold in the City of Wilmington, Del., by Dr. Wolf, shows a better result, the proportion of safe oils reaching as high as 12 per cent. It is probable, however, in view of the results published from other localities, that this showing is exceptionably favourable.

There seems to exist a notion that the explosive or inflammable properties of the light petroleums can be effectually neutralized by adding various substances to them. The Patent Office records for the past few years contain numbers of claims for such mixtures of naphtha or gasolene with a great variety of substances, too numerous to mention.

Whether or not the inventors of these recipes really have faith in the claims they present is a matter of small importance; but the deceptive illustrations which they are able to offer in vindication of their assertions, no less than the attractive names which they attach to their incendiary mixtures, are the fruitful sources of many distressing calamities.

There is one simple and, for practical purposes, satisfactory method of determining the character of all such mixtures, and which applies equally as well to the common oils. Let a few drops be poured into a saucer, and apply a match; if the material burns, reject it as unsafe. The fact that the material can be set on fire at the ordinary temperature of our dwellings should be a sufficient evidence to a person of ordinary intelligence that, when employed in the household for heating or lighting purposes, it may, at the first thoughtless or careless act, become the cause of a frightful accident.

Hanging or stationary lamps of great variety of form and design have been constructed for burning these light compounds; gas and vapour stoves in similar variety have been introduced for household heating and cooking; but all of them should be shunned like the plague, and left severely alone.

In addition, another question of much practical importance presents itself, namely, What is the temperature to which the oil within the body of a lamp is heated while being consumed? From what has already been presented for your consideration it will require no explanation to assert that no oil is safe which can under such circumstances be heated above its flashing point.

For your inspection I append herewith several tables, containing the results of an extended examination of this branch of the subject, published with the recent report of Dr. Chandler, before alluded to.

For the sake of completeness, similar experiments, though not upon so extensive a scale, were conducted by the writer, which fully confirmed the results herewith quoted.

These results indicate that with lamps in common use the temperature of the oil within may even rise above the point fixed by law as the temperature of safety, and furnish excellent reason to urge, as does the author of the tables, that the laws upon this vital subject should fix the flashing point of the oils used in the household at 120° Fahr., instead of at 100° Fahr., as is nominally the case at present.

The Temperature of Oil in burning Lamps.

First Series.—*Temperature of the Room 73 to 74° F.*

No.	Kind of Lamp.	Capacity of Lamp.	Temperature of the Oil. After one hour.	After two hours.	After four hours.	After seven hours.	Average for the seven hours.
	Air of the Room		73°	73°	74°	74°	74°
1	Brass hand lamp	8 oz.	85	82	85	86	84·5
2	Brass hand lamp	24	79	83	84	82	82
3	Glass stand lamp	8	77	78	79	80	78·5
4	Glass stand lamp	11	77	81	84	82	81
5	Glass stand lamp	20	78	79	79	80	79
6	Glass stand lamp	7	82	80	85	84	82·75
7	Glass stand lamp	10	84	86	84	82	84
8	Glass hand lamp	9	79	78	85	85	81·75
9	Glass hand lamp	6	81	82	86	86	83·75
10	Glass hand lamp	7	80	78			79
11	Brass student lamp	13	82	80	83	84	82·25
12	Glass stand lamp	10	81	81	79	78	79·75
13	Brass stand lamp	11	92	89	88	86	88·75
14	Tin lantern	7	89	86	88	87	87·5
15	Glass bracket lamp	19	82	82	84	83	82·75
16	Glass stand lamp	29	82	80	80	84	81·5
17	Brass student lamp	7	80		88		84
18	Brass stand lamp	14	84	85	87	87	85·75
19	Brass stand lamp	12	100	100	92	91	95·75
20	Metal stand lamp	9	82	82	88	87	84·75
21	Brass stand lamp	12	91	92	88	85	89
22	Bronze stand lamp	16	83	76	79	85	80·75
23	Glass hand lamp		79	80	82	82	80·75

"With the air of the room at from 73 to 74° F., the temperature of the oil in the burning lamps ranged from 76 to 100° F., the highest temperature of 100° having being reached in a metal lamp at the end of one hour. That this was an exceptionally high temperature is shown by the fact that the highest temperature reached in any other lamps was 92° F. The following is a synopsis of the observations:

	23 Lamps.	11 Metal Lamps.	12 Glass Lamps.
Highest temperature reached	100°	100°	86°
Lowest	76	76	76
Average temperature	83	86	81

SECOND SERIES.—*Temperature of the Room* 82° *to* 84° *F.*

No.	Kind of Lamp.	Capacity of Lamp.	Temperature of the Oil. After one hour.	After two hours.	After three hours.	After two hours.	Average for four hours.
	Air of the room		82°	83°	84°	83°	83°
1	Brass hand lamp	8 oz.	92	95	96	95	94·5
2	Brass hand lamp	24	88	94	94	93	92·25
3	Glass stand lamp	8	84	88	86	84	85·5
4	Glass stand lamp	11	84	86	86	84	85
5	Glass stand lamp	20	85	86	87	86	86
6	Glass stand lamp	7	86	87	88	88	87·25
7	Glass stand lamp	10	88	87	89	88	88
8	Glass hand lamp	9	87	90	90	90	89·25
9	Glass hand lamp	6	87	91	89	87	88·5
10	Glass hand lamp	7	84	86	86	84	85
11	Brass student lamp	13	86	88	88	88	87·5
12	Glass stand lamp	10	85	86	86	85	85·5
13	Brass stand lamp	11	104	103	101	101	102·25
14	Tin lantern	7	95	96	94	96	95·25
15	Glass bracket lamp	19	84	85	84	84	84·25
16	Brass stand lamp	29	84	85	84	84	84·25
17	Glass student lamp	7	87	88	86	84	86·25
18	Brass student lamp	14	91	93	92	91	91·75
19	Brass stand lamp	12	101	100	98	96	98·75
20	Metal stand lamp	9	89	92	94	93	92
21	Brass stand lamp	12	88	98	94	96	94
22	Bronze stand lamp	16	82	88	88	89	86·75
23	Glass hand lamp	6	84	86	85	84	84·75
24	Brass student lamp	10	120	120	120	118	119·5
25	Brass student lamp	12½	112	115	115	116	115

"With the air of the room at from 82° to 84° F., the temperature of the oil in the burning lamps ranged from 82° to 120° F. The temperature 120° was exceptional, being confined to one lamp. The following is a synopsis of the observations:

	In 23 Metal Lamps.	In 12 Glass Lamps.	In 25 Lamps.
Highest temperature reached,	120°	91°	120°
Lowest " "	82	84	82
Average " "	96½	86	91½

THIRD SERIES.—*Temperature of Room* 90° *to* 92° *F.*

No.	Kind of Lamp.	Capacity of Lamp.	Temperature of the Oil. After one hour.	After two hours.	After three hours.	After four hours.	Average for four hours.
	Air of the room		92°	90°	92°	90°	91°
1	Brass hand lamp	8 oz.	90	93	100	98	96·5
2	Brass hand lamp	24	99	98	102	100	97·25
3	Glass stand lamp	8	88	90	93	94	91·25
4	Glass stand lamp	11	88	92	94	94	92
5	Glass stand lamp	20	85	92	94	94	91·25
6	Glass stand lamp	7	80	94	96	93	93·25
7	Glass stand lamp	10	90	96	96	96	94·5
8	Glass hand lamp	9	88	95	98	98	94·75
9	Glass hand lamp	6	89	95	96	97	94·25
10	Glass hand lamp	7	88	92	93	94	91·75
11	Brass student lamp	13	89	100	102	102	98·25
12	Glass stand lamp	10	88	92	93	93	91·5
13	Brass stand lamp	11	106	114	116	110	111·5
14	Tin lantern	7	99	106	107	105	104·25
15	Glass bracket lamp	19	85	92	91	91	89·75
16	Glass stand lamp	29	86	91	92	92	90·25
17	Brass student lamp	7	92	99	100	100	97·75
18	Brass student lamp	14	94	100	100	100	98·5
19	Brass stand lamp	12	108	112	112	107	109·75
20	Metal stand lamp	9	91	96	100	99	96·5
21	Brass stand lamp	12	104	110	108	106	107
22	Bronze stand lamp	16	84	90	95	98	91·75
23	Glass hand lamp	6	90	92	94	94	92·5
24	Brass student lamp	10	124	129	129	128	127·5
25	Brass student lamp	12½	120	126	127	127	125

"With the air of the room at from 90° to 92° F., the temperature of the oil in the burning lamps ranged from 84° to 129° F. The highest temperature being exceptional. The following is a synopsis of the observations:

	In 25 Lamps.	In 13 Metal Lamps.	In 12 Glass Lamps.
Highest temperature observed,	129°	129°	98°
Lowest " "	84	84	85
Average " "	98¾	104½	92½

"By these results it appears that the temperature of oil in lamps often rises much above 100° F., thus reaching a temperature at which oil, *which does not emit a combustible vapour below* 100° *F.*, would be dangerous. It is apparent that 100° F. is too low a standard for safety; 120° F. would not be too high a standard, and its adoption would add but a few cents per gallon to the cost of the oil."

In view, therefore, of the facts here set forth, there would seem to be but one remedy available to the thinking portion of the community, namely, to urge the legislative bodies, with all the earnestness which the gravity of the existing condition of the subject demands, to make, with the least possible delay, such amendments to the laws regulating the sale and inspection of the petroleum oils, as shall render inspection a reality instead of a farce, which shall positively prohibit the sale or use of the dangerous petroleum products for household heating or illuminating purposes, and which shall punish with a severity commensurate with the gravity of the offence any violation of them, whether committed through ignorance or intention. The remedy here suggested could simply be reached by a judicious modification of the existing laws; and their vigorous enforcement would prove an effectual barrier against the sale of the adulterated stuff which now provides almost every household with a treacherous, insidious enemy.

Continuing the consideration of the modern innovations in the field of illumination, certain methods, by which the light oils of petroleum (gasolene especially) are made use of, to improve the illuminating power of ordinary burning gas, warrant attention. These processes are essentially the same in principle, though differing very greatly in the details of the devices in carrying out the idea; and when carried into effect, with certain obvious precautions, which will be referred to hereafter, are, to some extent, though by no means entirely, free from the vital objections on the score of danger, upon which so much stress has been laid in the preceding pages of this report. And the writer begs leave, once for all, to state his firm conviction, that it would prove a matter of inestimable benefit, if some method should be discovered and applied, either for converting these volatile bodies into useful and harmless compounds, or if some process should be devised for utilizing them largely in the industrial arts. By either of these remedies the direct employment of the light oils for household illumination could be altogether avoided; since, though the ingenuity of invention may be exercised to devise preventives and precautions against accident with them, it is very gravely to be doubted, from the very nature of the materials, whether they can ever be so employed with a reasonable degree of safety.

The philosophy of the processes here referred to will be more clearly understood by a general reference to the principles involved in the utilization of illuminating agents. These are generally compounds of carbon and hydrogen, the so-called hydro-carbons, and are either already in the gaseous state, or are converted to this condition in the process of burning. A certain proportion of these elements is, however, necessary, in order that the illuminant shall burn with proper brilliancy. To the hydrogen of the burning body is to be mainly ascribed the heating power of its flame, while to the carbon alone are we indebted for its illuminating qualities. It is, therefore, possible that a hydro-carbon may possess too much hydrogen in proportion to its percentage of carbon (as is the case with the light carburetted hydrogen, for example), when the effect will be that of a hot flame, but almost or entirely blue, and with little or no light-giving power. Or, on the other hand, the burning body may contain an excessive proportion of carbon (as is the case, for example, with turpentine oil), when the result will be a dull red, dirty, smoking flame, which, though giving out more light than the first, is utterly objectionable on the score of the abomination of its smoke. It is, therefore, a matter of the first importance that, in an illuminant, these essential constituents shall be present in such proportions as shall produce the best illuminating effect.

With the common burning gas, the reason of its very general inferiority is to be referred to the large percentage of the light carburetted hydrogen gas and of free hydrogen itself, which it contains. The rationale of the introduction of these feeble or non-illuminating ingredients into the gas is not difficult to comprehend if a glance be taken at the operation of its manufacture.

In the process of obtaining burning-gas from fat coal, which is the one almost universally employed in gas-works, the rich, light-giving gas is evolved during the earlier portions of the heat; but, owing to the natural desire of the companies to secure from a charge the largest quantity of gas, the heat is continued for a considerable time after the richer portions of the gas have passed off; the consequence of which is, that the gas passed over in the holder during this period is very largely composed of hydrogen, which has no illuminating power, and of the light carburetted hydrogen, which is not much better.

The fact that the gas supplied for household consumption is generally but of indifferent quality, mainly from the cause specified above, has originated a number of plans for improving its brilliancy, by supplying it indirectly with a portion of the constituent in which it is lacking, namely, carbon. This process involves the passage of the gas, before consumption, through a reservoir of some one of the light petroleum oils, preferably gasolene, on account of its eminent volatility; by which treatment it becomes charged to saturation with the

vapour of this material, the illuminating power of which is very superior, and comes to the burner greatly improved in quality.

This process, which bears the name of "carburetting," has received, in several cities, a limited introduction. The volume of the gas is by this process considerably increased, as well as its illuminating power; and this, together with the cheapness of the carburetting material, the smaller quantity of gas which need be consumed to produce a given amount of light, as compared with that which would be required without its presence, combine to considerably diminish the expense of employing gas—an item, it must be granted, of no inconsiderable importance in large establishments where a large number of burners are regularly in operation. And it is in such establishments that this plan, or others, which will presently be alluded to, have been received with the most favour.

Where a limited number of burners are in requisition, as in smaller workshops, stores or private dwellings, the saving which may thus be effected in the item of expense, is scarcely a matter sufficiently important to offset the disagreeable routine of attention which it is necessary to devote to the apparatus to keep it in effective operation. Other incidental difficulties, such as the natural hesitation on the part of those familiar with the unavoidable risk entailed upon the handling of the carburetting material, and perhaps the still more cogent reason, that the insurance interests have, in most localities, prudently refused to sanction or permit the introduction of the process, in connection with risks assumed by them, have so combined to limit the application of the process of carburetting, that it is, though not new, still comparatively unknown to the general public.

Although the introduction of any of the lighter oils of petroleum into buildings for illuminating purposes will be discountenanced by all who seriously and candidly reflect upon the unavoidable risks which attend their employment, it must still be granted that, if these substances are to be employed at all, this and allied plans, in which the inflammable material is securely confined in a metallic reservoir, is infinitely to be preferred to the practice of using them in the lamps or stoves.

In connection with the modern processes for the utilization of the light petroleum oils, there remain yet to be reviewed a number of plans by which this is accomplished directly; although, through the intervention of appliances considerably more complex than the portable lamps. Reference is here made to the numerous devices which are popularly termed gas machines.

These consist, in general terms, of a reservoir, generally a strong metallic vessel, supplied with the oil to be utilized, through or over which a regulated supply of air (or in some cases of hydrogen) is passed, the illuminating agent resulting from this contact being then led, by the usual distribution-pipes to the burners. In the simplest form of apparatus operating upon this principle, this result is accomplished by permitting the gasolene vapour, which is considerably heavier than the air, to fall, in virtue of its gravity, down a descending pipe, and thus, by the current established, induce a flow of air over the surface of the oil. The material is suitably contained within a reservoir provided with an opening at one extremity, to permit of the access of the air, and further, with a series of alternating, imperfect partitions. The object of the latter is to increase the amount of contact between the entering air and oil, and to effect what would be equivalent to a large evaporating surface. The more rapidly the gas is consumed from the burners, the more rapid will be the evaporating process, which will, of course, cease as soon as the burners are turned off. Thus, by ingeniously taking advantage of the extreme volatility of the light oil, an air-current is induced, by which an abundant supply of excellent illuminating gas is obtained automatically, without the introduction of any appliance other than the reservoir with its simple partitions. This plan, though very interesting, from its simplicity and the scientific principle which it so ingeniously illustrates, involves the serious necessity of placing the reservoir of oil in the upper story of the building to be lighted. It contains the essential features, though the object is attained in the simplest possible manner, of all the numerous gas-machines. In the others, a fan or its equivalent is employed to blow into the reservoir a stream of air. Though somewhat more complex in construction, this form of the apparatus is less objectionable than that first described, from the fact that the reservoir of oil may be located at a considerable distance from the house, and beneath the ground, in a pit prepared for the purpose—thus lessening the risk by lessening its proximity to the building endangered by its presence; though, with all of them, the personal dangers attending the replenishing of the reservoir, remain the same, as does also the liability to explosion when a leakage occurs or, from an accidental deficiency of oil in the reservoir, or extremely cold weather, a defect in the proper working of the apparatus, or from any other cause, an excess of air is introduced by the blower. Where such a condition of things occurs, an explosion is the inevitable consequence, since the instant the proper mixture of air and vapour is reached, the combustion of the gas at the burners will dart instantly back to the reservoir with all the explosive violence of gunpowder.

With the hydrogen machine, where a current of hydrogen gas (generated, in an appropriate vessel, from the action of diluted sulphuric acid upon iron scrap) is passed through the reservoir of oil, though it seems not to be so liable to an accident from this source, and affords a light much superior to that obtainable with the other forms of machine, it is more obviously objectionable, on the score of complexity of the operations involved in its working, not the least of which consists in the replenishing, from time to time, of the generating vessel; an operation which, from the character of the acid and its refuse, is a most disagreeable one. Another objection, however, which far more effectually extinguishes the possibility of this process ever gaining popularity, resides in the fact that the gas obtained by it costs, to say the least, three times as much per thousand feet as the ordinary burning gas. The sale of the refuse to the manufacturing chemist, for the extraction of the green vitriol, and the diminution in the quantity of gas consumed, by reason of its excellent illuminating quality, may effect a slight reduction in the grave item of expense, but this will, even under the most favourable circumstances, be too great to permit of any other than a very limited introduction.

With this somewhat lengthy consideration, the gas machines may be passed by; though, in conclusion of this branch of the subject, a few words upon their merits may not be thrown away.

They possess, one and all, the objectionable feature of employing the incendiary petroleum oils; and though they, as a class, reduce the danger of its presence to a minimum, by confining the material in a strong metallic vessel, and by locating this at some distance from the buildings to be lighted, the danger from disarrangement or carelessness is but incompletely guarded against, as has already been pointed out, and the personal risk involved in the execution of the routine of attention, which they demand, remains unprovided for.

In the foregoing pages, the entire unfitness of the light petroleum oils has been urged, under whatever name, or with any form of lamp or machine, as household illuminating or heating agents, from the belief that under no circumstances can these substances be so employed without great risk; with the least objectionable modes of their application, namely, in the carburetter and the gas machine, the writer was, until lately, of the opinion that they might, with the exercise of well-defined precautions, be used with a reasonable degree of safety; but a thorough examination, with the knowledge gathered from a more extended acquaintance with the statistics of the subject, have prompted a revocation of that opinion and this expression of it.

There is no field, at present, in which invention would prove of such eminent service to the community at large, as in that of devising methods by which these oils would be utilized upon a vast scale, and thus effect their withdrawal from those applications in which their dangerous qualities are so prominently involved, to the constant peril of life and property. That this object will ultimately be accomplished there can be no doubt. Already, large quantities of these materials are exported, to be converted into permanent illuminating gas, by a process analogous to that employed in our gas-works, the retort and its setting being modified to suit the purpose. Their utilization in other departments of the industrial arts is gradually extending, and it is sincerely to be wished that the time may be not far distant when the demand for them in these legitimate fields of employment may be more than sufficient to meet the supply. As an indication that progress is being made in this direction, this report, which has grown into far more considerable proportions than was originally intended, may be appropriately concluded by a description of the most recent of all the plans for illumination, and in which the light petroleums are called upon to do good and proper service.

The plan consists of three distinct steps: First, the continuous production of hydrogen gas; second, the passage of the hydrogen through a well of the light oils; and third and most important, the conversion of the vapour-laden hydrogen into a permanent gas.

The first step in this ingenious invention consists in leading steam into a furnace charged with coke and heated to redness, by which process hydrogen and carbonic oxide are formed. From this mixture the carbonic oxide is removed by passing the gases through cylinders of hydrated lime heated to redness. The result of this treatment is the formation of a fresh equivalent of hydrogen, and the conversion of the carbonic oxide

into carbonic acid by union with the oxygen of the decomposed water of hydration. The carbonic acid is removed from the hydrogen by passing through more lime, and the hydrogen is passed onward into another chamber, where it comes into intimate contact with a body of light petroleum oil. Here it loads itself with the oil-vapour, and continues on its course, passing next through tubes heated to a low, red heat, whereby a permanent coal-gas is formed precisely analogous in all its properties to the ordinary coal-gas, though superior to the last (as ordinarily furnished to the public) in illuminating quality.

A process which would secure to those living remote from cities, and who are necessarily deprived of the luxury of coal-gas, some substitute for the petroleum gas machine, which shall equal it in the quality of its illuminant, but at the same time shall be free from its objectionable features, would be a more direct means of effecting this much-to-be-desired result, though it affords a problem far more difficult of solution.

In the report herewith submitted to you, it has been my constant effort to present for your consideration, the facts at my disposal freed from any bias.

In the city of Baltimore, during the past year, 69 fires were caused by petroleum and its products. During the same period, in the city of New York, there were 203 from the same cause; while in your own city, no less than 59, or more than from any other single cause, are officially announced to have occurred.

Many of these disasters were accompanied with considerable pecuniary loss, and not a few with deplorable loss of life or injury of person; and I need hardly remind you that the memorable calamity at Chicago, which has become historical from its appalling magnitude, is popularly ascribed to a similar cause.

Suitable laws respecting the sale and employment of these substances, rigidly enforced, might have averted the greater number of these misfortunes.

It is for you, gentlemen of the committee, to present your convictions upon this subject so forcibly as to leave no ambiguity in the public mind as to your meaning; and thus, by the authority which any recommendation from you must carry with it, to pave the way for that stringent legislation upon this matter which is so urgently needed.

If the matter herewith presented for your consideration proves of any service in adding force to such an expression from you, I shall regard my labour as not having been altogether in vain.

Very respectfully yours,

WILLIAM H. WAHL.

To Messrs. J. B. Burleigh, Ch'n, Frederick Fraley, Henry Cartwright, Chas. S. Close, Dr. George A. Kœnig, Dr. T. R. Wolf, Committee.

COTTON PICKING AND THE COTTON PLANTER'S CALENDAR.[1]

THE little volume from which we take the following sections is one of interest to all connected with the cotton trade. As the author emphatically remarks at the opening of his preface, "The treatise is not a compilation." He adds:—Agricultural literature is by no means so rich in valuable works on the Cotton Plant that it is possible to select from existing writings the information which, however skilfully grouped, can make an excellent book.

Twelve years of experience among the cotton growers of the South-west have been found by the author of vastly more importance to the proper understanding of the whole subject, than all which has been written.

Of what has been before given to the world on the subject, I have found no matter more valuable than the letters of Dr. Cloud, of Alabama, who did more for the true and scientific culture of the plant than all the other Southern writers put together.

His views, and those of that Bayou Sara planter who wrote an admirable letter to "De Bow's Review on the Cotton-worm," have been freely quoted. Some useful statistics are to be found in the "New American Cyclopædia," under the head of Cotton; and these, as well as other tables, have been studied. The writer would also express his obligations to Mr. Edward Atkinson, of Boston, whose lecture before the Geographical Society of New York is rich in valuable conclusions.

But whatever is of most worth in the pages that follow, is the result of personal observation, and of frequent and lengthy conversations with the most successful and the most intelligent cultivators of the great staple.

[1] New York: Orange, Judd, and Co.

COTTON PICKING.

Early in August the fortunate and enterprising planter will walk in from a survey of his crop with two or three open bolls in his hand. His harvest is approaching. He plans to have his fodder pulling done in a week, if not already over, and he looks after his sacks and baskets. A yard and a-half or two yards of strong Lowell, made into a wide-mouthed sack, and furnished with a broad double strap to go over the neck, is provided for every hand on the place.

The mouth or opening should be made so as to hang open convenient for the picker. A cord or rope, as big as the little finger, sewed all around the top on the *outside*, helps to keep the bag open. The length of the strap and depth of the bag should be carefully adjusted to the size and figure of the labourer, for the planter can ill afford to waste the strength or needlessly multiply the motions of a picker. Each hand should also have his basket. These are made of wide white oak splits, coarse in texture, not very heavy, and capable of holding about four bushels. It is very well to have each sack and each basket branded or otherwise marked with the name of the labourer, as it prevents confusion, and it is well known that a workman is always better satisfied to feel that he has absolute and certain control of his tools.

As soon as you can look down between two rows of cotton, and count half a dozen open bolls, start in the pickers. They will get more than it seems likely that they would, and, if active, will probably come out with forty or fifty pounds. From this time on till nearly Christmas the one great business on a cotton plantation, to which everything else must yield, and in which every available finger should be employed, is picking. There is no crop known, at least in this country, of which the harvesting is so long and monotonous. One boll is just like another, one row the fac simile of its neighbour. There is no science or ingenuity that has been brought, or is likely to be made effectual in very much modifying, abridging, or lightening this labour. In the nature of things, it must be done by the fingers, and by the fingers only, in order to be done well. The green seed or Mexican and Petit Gulf cotton, which is the variety chiefly cultivated in this country, when fully mature opens its burr or shell quite wide, and the mass of cotton within gradually falls outward, and droops by the weight of the seeds. At some periods of the picking season, for instance during the month of October, these open bolls, with the handful of snowy fibre hanging loose and fleecy, sometimes six or eight inches downward from the stem, present a beautiful and interesting sight.

It seems like very easy work to gather a material which shows itself in such abundance as fairly to whiten the field, but let the sceptic or the grumbler take a bag on his shoulder, and start in between a couple of rows. He will find, upon taking hold of the first boll, that the fibres are quite firmly attached to the interior lining of the pod, and if he makes a quick snatch, thinking to gather the entire lock, he will only tear it in two, or leave considerable adhering to the pod. And yet he may notice that an experienced picker will gather the cotton, and lay his fingers into the middle of the open pod with a certain expertness which only practice gives; the effect of which is to clear the whole pod with one movement of the hand. Even long practice does not enable every labourer to become a rapid picker, no more than every printer is a fast compositor. There is a knack in cotton picking as in type setting, which cannot be acquired by all. Women generally make the fastest pickers, and next to them will be found the small, compact young man, weighing about 140 pounds, and not more than five feet eight inches in height. Good pickers are generally quiet, sometimes not speaking a word from one end of the row to the other. They are persons who habitually keep their minds directly on the thing in hand, and who, by the constitution of their bodies, enjoy the intensity of swift motions, and naturally love to accomplish a good deal in what they are doing. When the bag attains the weight of, say, twenty-five pounds or more, there should be a convenient arrangement for transferring its contents to the basket. It is here that the skill and calculation of a planter are manifested. For instance, if you set your baskets beside one of the plantation roads, and start your hands in to go from there to the other side of the field and back, they may gather twenty-five pounds in the outward trip. Then coming back to the baskets, they will gather twenty-five more. It is easy to see that the last half of the load will be collected with very much more fatigue and inconvenience than the first half; for, in addition to the labour of picking, the labourer has to carry on his homeward trip twenty-five pounds weight, which is continually increasing until it becomes fifty before he is relieved of it. Picking, though not heavy work, is

tiresome, and in the last degree monotonous, so that regard for the comfort of the labourer, as well as desire to advance the work, will suggest that the planter make every possible arrangement to relieve and lighten the task, and enable the picker to take his work at the very best advantage.

Let the field be divided up by lanes and roads in such a way that the picker will never carry much weight in his bag. The bags are emptied into the basket as soon as filled, and it is desirable that the hands should keep along together so as to come out about the same time. In fact, it is policy to let the fast pickers work some on the rows of the young and slow pickers. This gives encouragement, keeps the gang of labourers together, and stimulates the slower ones to keep up. Nothing is more disheartening to a young or feeble picker than to find himself two or three hundred yards in the rear of the main force, tired, with a heavy bag, all the time painfully conscious of his inferiority to the rest, and perhaps too frequently reminded of it by harsh and discouraging words. Though too much talking and singing must interfere with labour, it is earnestly recommended to every cotton grower to take care to secure cheerfulness, if not hilarity, in the field.

Remember that it is a very severe strain upon the patience and spirits of any one to be urged to rapid labour of precisely the same description, day after day, week after week, month after month. Humanity, to say nothing of self-interest (and here humanity and self-interest are identical), must suggest various cheap and harmless modes of relieving the tedium of this kind of labour. For instance, let there be refreshments at the baskets, a dish of hot coffee in a cool morning, or a pail of buttermilk in a hot afternoon, or a tub of sweetened water, or a basket of apples, so that when the gang come out from between the rows, and empty their bags, they may for a few moments enjoy themselves, take a little rest, and indulge in a harmless joke before setting in again. They will be certain to more than make up the time by the swiftness with which their fingers will spring from one snowy boll to another; and swiftness of movement is, of all things, what you most need in order to harvest your crop in good time and in good condition. This cannot be expected where the spirits droop and life is made to seem burdensome. Additional wages should also be paid to the largest pickers. It may be best, in some cases, to change the terms of labour in the picking time, and pay so many cents for every hundred pounds; but as the picking varies greatly, according to the openness of the bolls, this is not so good a plan as to give a bonus of so much for every ten pounds over one hundred or one hundred and fifty or two hundred which the picker brings in at night. Care should be taken also to abridge all the labour that is done after the picking ceases at night. The health of your force requires this, for during the principal part of the picking season the contrast between the temperature of midday and after nightfall is very great, and chill and fever must follow where a person is exposed to both without corresponding change of dress. The practice on a great number of the plantations in the Gulf States, under the old *régime*, was decidedly faulty in this respect.

The hands were expected to be in the field at early dawn, and commence picking as soon as they could see. In September, and much more so in October, and the following months of autumn, the dews are heavy and cold. The clothing becomes wet, and the frame chilled, in the raw morning air. But soon after sunrise the temperature begins to rise rapidly, and by ten o'clock the thermometer may stand between seventy and eighty degrees. This degree of heat continues for several hours, but declines very fast at sunset, so as to be as low as forty by the time the stars appear. The cotton field will naturally be situated on the lowest lands, and at night the malarious air falls, so as to make them the most unwholesome of any in the vicinity. The effect of exposing labourers daily to such vicissitudes can easily be imagined.

About nine o'clock in the morning, one and another of a gang of labourers would come out of the field, sick with a violent chill. This would be followed by a high fever, and the hand kept from earning anything for three or four days, and often a week.

There is no time in the year when the cotton grower can so ill afford to have his force diminished as in the picking season. Labour is then everywhere in demand. Good pickers can always command high wages, and everybody that can work is then occupied.

Let the planter remember that an ounce of prevention is worth a pound of cure. Coffee is the most agreeable preventive of miasmatic disease, and quinine the most effective. In picking time every plantation on low lands should be supplied with both, and should use the former with liberality and the latter in moderation.

Let the pickers have the sunlight upon them the whole time of their being at work. Kindle a fire at the baskets before they go out, set on a big pot or kettle of coffee, and have it boiling before sunrise. Give each hand a half pint of it, and with it a hard cracker, a roast potato, or a piece of bread. Then, at eight, provide breakfast. Let the work be brisk till nearly sunset, pausing only for dinner, and manage to have the day's picking weighed and stored away in the gin-house or in cribs made for the purpose, before the dew falls upon it.

Though such is not the custom, probably there is no time so favourable for sorting and thrashing cotton as when it is first picked. It is less matted then than at any subsequent handling, and the particles of leaf and stalk and dirt are not entangled in the fibre, as they afterwards become. Instead of weighing the baskets, each hand, as he comes out, can hang his bag upon the hook of a spring balance before he empties it. Then let an invalid, an old person, or a woman, sit by the baskets, and sort over and trash the contents of each bag.

Cotton of the Mexican, Petit Gulf, and Okra varieties (all of which are "green seed" cottons, differing very little in appearance), will naturally class into four grades, as it comes from the field.

First.—The fine, long-stapled cotton, clean, dry, and silken to the touch. This will greatly predominate in the early pickings, before the frosts and the heavy fall rains occur.

Second.—The short, kinky bolls, that have been bored by the boll worm, and not quite killed, or which came late, and were unclenched by the frost, or which grew under the disadvantage of excessive or irregular moisture.

Third.—Trashy cotton. This abounds after the heavy frosts, and the trash consists of minute fragments of leaves and stems that become hopelessly mixed with the fibres, so as never to be entirely removed. They cause the small, black specks that abound in the coarser varieties of Lowells and Osnaburgs.

Fourth.—Dirty cotton. This comes in after heavy rains, accompanied by winds, which have blown out the contents of the pods, and beaten it into the earth, or driven sand all through the fibres.

During the months of September and October there is no need of having much trashy or dirty cotton. That which is kinky or imperfectly developed should be carefully separated from the best, and either kept by itself or thrown with the other low grades. The manufacturer can use it in making strong, coarse fabrics.

The cotton of long staple and high grade should not be allowed to become damp with dew, but taken while still warm and dry and stored in a shed or in the gin-house, and lie a month or two before it is ginned. This gives the oil in the seeds time to ascend into the fibres, thus imparting a fine, pale, straw colour, which the manufacturer loves to see, and also increasing the weight.

It is almost impossible, after the heavy frosts, to pick cotton free of trash, and where the crop is large more than half of it may come under this description. In some conditions of the market, planters find the difference between trashy and clean cotton so little as to discourage them from efforts to send a fine article to market. But, in general, moderate painstaking will enable the grower to command from two to five cents more per pound.

The thoughtful planter will also manage so as to have the cotton handled as few times as possible, both to economize labour, finish work as early as possible, and prevent his staple from becoming matted and dirty. Where ten baskets are to be emptied twice a day, there is no need of pouring them into a great box waggon, stamping down, and then unloading, by filling the basket again at the crib or gin-house. When the work is in a remote field, and the weighing is done by torchlight, the hands about the waggons may not get their suppers till eight or nine o'clock.

Where the roads are good, an excellent plan is to couple the fore and hind wheels of a waggon with a pole of proper length, lay two other poles or long planks on the axle trees, set the basket on them, and empty at the gin-house. If the weighing is done in a bag, this is entirely practicable, and allows all the hands to get to their houses in half an hour after they came out from the rows. Where the number of baskets is large, some other plan can easily be devised by one who is studying how to get the greatest amount of work done in the shortest time and with the least wear of muscle.

The month of October is the height of the picking season in the best cotton regions. Many fields that were rapidly picked early in September are now literally "white for the harvest." Now the planter cannot urge his work too zealously. But let him not, in his pushing, encroach upon the hours of relaxation and sleep. His rule should be: "Gather no cotton upon which the sun is not shining, and to pay high for fast picking rather than for night work."

At times, in the picking season, it will be advisable to divide the force, especially where it is large, into "fast pickers" and "the trash gang," instructing the former to press along, and gather rapidly all the fair clean cotton that is hanging open on the upper branches of the bush, the others to follow, gleaning all that remains, the imperfect bolls, that which has fallen to the ground, or been trailed in the dirt.

The picking season lasts from three to four months, including all of September, October, and November, and frequently a part of August and December. But where cotton opens early, there is no reason why it should not be nearly all gathered by the 10th of December.

In the older regions of the South, as Georgia and South Carolina, it has been the usual practice to weigh but once a day, and to require a hundred and fifty pounds as a day's work. In good open cotton, a fast hand will gather this amount in five or six hours, but in the beginning, as at the close of the season, the whole day will be consumed in picking this number of pounds.

It requires rather more than three times the weight of lint to make a given amount of unginned cotton. Thus, from fifteen to eighteen hundred pounds of cotton in the seed will be required in making a bale of the usual weight. Ten good hands can pick a bale per day. Hence, if ten hands have planted a hundred acres, which proves a good crop, they will consume a hundred days in picking it out.

The Cotton Planter's Calendar.

What follows is in the nature of a summary and recapitulation of much that is set forth in detail in the volume. It is calculated for about the middle of the cotton belt, or the lands where cotton is produced, between the thirty-second and the thirty-fourth degree of north latitude. Some other crops, such as corn, peas, and oats, are alluded to, as they are cultivated more or less on every plantation.

JANUARY.

The gin is to be kept running most of the time during this month on last year's crop. It is best to have a convenient scaffold arranged on the south side of your gin, of an easy slope, and passing directly to the gin loft, so that cotton can be taken from the sheds or cribs, dried, and carried up to where it will feed itself into the gin, or can be pulled in by the operator before the stand.

Read the papers, keep informed as to rise or decline in the cotton market, the supply and demand.

Have a powerful press, sufficient to put four hundred pounds into the space of forty cubic feet. Use wide iron hoops, and plenty of them. Look well after the ends of your bales, and see that they are perfectly snug.

On pleasant days the hands may be breaking down the cotton stalks or clearing new land.

This is a good time also to fill up washes and old gulches in the field, and prevent little ones from growing any larger. Cut down pine bushes, and lay them in the washes lengthwise; cane from the cane-brakes answers the same purpose very well. Take care of your cotton seed at this time. That which is intended for planting should be stored in a shed or loft, where the air has free access, and stirred to prevent fermentation. The rest should be carefully saved for manure. The ashes of it were found, by one analysis, to contain 55 per cent. of potash; and if it is faithfully returned to the cotton field, and your lands prevented from washing, cotton will be found a very slow exhauster of the soil.

FEBRUARY.

You must expect numerous and heavy rains this month; but on porous soils, after the 12th or 15th, it will be dry enough to plough.

This is the proper time for projecting the crop of another year, obtaining hands, fixing them in comfortable quarters, and purchasing additional mules and other stock.

Cut and haul a supply of wood. Haul out your cotton seed and other manures, and spread them on the fields. Decide as to rotation of crops; where you will have your cotton, where your corn, oats, and sweet potatoes.

After the middle of the month, whenever it is dry enough, let the two-horse ploughs be throwing up beds for the cotton rows. Four feet apart on hill lands, and five or five and a-half in the swamp, is the rule.

Cotton that stands thick will produce as many open bolls before frost as that which is thinner, and it is the open bolls before frost that will give you the best cotton.

Get in a few acres of oats.

MARCH.

The first ploughing continued briskly. Corn lands ploughed thoroughly, and oats sowed. Have a large kitchen garden, raise plenty of cabbages, sugar beets, carrots, parsnips, onions, okra, and melons.

A cotton soil and climate are exactly suited to melons, and it will pay to put an acre in water melons and cantelopes.

This is a proper time for working plantation roads, filling up the washes, and laying off circle ditches on hill lands. By circle ditching and circle ploughing, you can cultivate a soil that is as mellow as an ash heap on a side hill, and yet keep it from washing away.

Observation will teach you what fall a ditch may have, and not wash. It is different in different soils. A fall of an inch in ten feet is the rule that some follow.

If the season is early and dry, you can plant in the last of March. It is desirable to get your corn planting out of the way before you commence on cotton.

APRIL.

A busy month this for the cotton planter. He must make every edge cut, particularly if he has grassy fields. The first of the month will be taken up with cotton planting. You cannot be too thorough or particular in getting in your seed. Aim to have mellow beds, and straight, even rows. Run a fine-toothed harrow over the tops of your beds, and fasten on the cross-piece, so as to project behind the middle of the harrow, a triangular piece of wood, with the edge down, so as to make a clean, even trench for your seed, which should be soaked in a fertilizing mixture a day or two, and rolled, while damp, in ashes and plaster.

Drop your seeds at intervals of an inch or two in the bottom of the little trench, and cover with a board attached to a light plough, notched so as to fit the curve of the bed.

As soon as your cotton is planted, go over your corn for the first time, and turn immediately back to the cotton field to give it the first working.

Try the Shanghai plough for the first working. Some planters speak very highly of it. You may, perhaps, do almost as well by taking out the three forward hoes of your cultivator, and passing it along above the young plants and astride of the row.

Let the hoes follow the ploughs, cutting away two breadths of a common hoe, thus leaving a clump of plants at intervals of about a foot and a-half. In some cases, where your plants are vigorous and the season pushes, it may do very well to cut away to a stand at once, or, at least, so as to leave but two thrifty plants in a place. At all events, keep down the grass. If you have to go over your crop once in a week, get the grass under now, and it will not give you much trouble during the rest of the season.

MAY.

Another crowding month on a cotton farm. Both crops, your corn and your cotton, demand attention, and neglect now can never be made up.

During the first half of May you will give the cotton its most thorough working. Let the ploughs keep a brisk pace if they have much ground to go over. They should go around the first time moulding the rows, and be followed close by the hoes, to uncover the plants that have been buried by the plough running too near. Then the middles should be broken out, and the crop left perfectly clean, cut out to a permanent stand, and the ground all stirred.

After running two furrows to each row, so that the hoes can go over the crop, it may be advisable to put the ploughs into the corn field, and let them go through that before breaking out the middles of the cotton. Some time must be found also for the potato patch. Work them clean and hill up thoroughly. The vines will soon monopolize the surface and exclude the weeds and grass.

Towards the last of the month get the ploughs back into the cotton. The sweep is probably the best implement to put into the field now. Any blacksmith can convert a common bull-tongue or a scooter plough into a sweep or eagle, by putting a wing to the lower part of the coulter, two or three inches from the point. A good ploughman can carry his sweep within two inches of the line of plants without killing any. This greatly abridges the labour of the hoe hands.

JUNE.

In this month the cultivation of cotton must vary somewhat with the season and the soil.

If you are planting on rolling or hilly land, and the season is dry, throw up a considerable furrow from the middle to the roots of the plant. On bottom land this is unnecessary, for cotton on alluvial soil seldom suffers much from drouth. On the other

hand, on flat lands, if the season is wet, you will have to throw up a ridge to prevent water from settling around the roots.

The ploughs continue to run actively all this month, both in corn and cotton. It is well to accustom the mules and horses to a rapid walk between the rows. Use an animal but half of these long hot days. Commence early, and give a long nooning. Hold each ploughman responsible for the condition of his mule, and allow a bonus or extra wages to the one that brings his animal out of the crop in the best condition.

Look well after the comfort of man and beast these blazing days, when the thermometer stands at 120° in the field. Give the hands plenty of drink, but let it be acidulated, such as vinegar and water, or buttermilk, somewhat diluted.

JULY.

You will go over your corn for the last time this month, if the season is dry. A stirring of the soil between the rows will help it to resist the effect of the intense heat, and prevent the lower leaves from "firing." Cotton needs another ploughing; but if the previous cultivation has been thorough, the crop can be laid by the last of this month.

As soon as your corn is "past roasting ear," pull fodder. As this work is by no means easy, and comes in the height of midsummer heat, some of the hands are quite likely to injure themselves unless special care is exercised.

Drenched as they are with perspiration, they must drink frequently, and the water should never be cold. If vinegar and a little sugar is added, all the better. There is no use in pushing labourers now. A press of work is soon to come, and you do not want to start a set of jaded and half-sick hands to picking.

Some have doubted the propriety of stripping the leaves from Indian corn before the ears are mature. You lose a little in the weight of shelled corn and in its fattening properties, but for the southern climate a more wholesome corn is produced in this way than by allowing the whole plant to stand till dead ripe. It will not be so heating to animals, and the bread made from it is lighter and more palatable.

AUGUST.

The picking season is at hand. Store your dry fodder, and get ready to send every hand into the cotton field.

About the middle of the month you will observe quite a number of the lower or ground bolls open. As soon as a picker can gather fifty pounds, the work of harvesting begins. It will continue three and a-half or four months.

This is the time of year to be on the watch against your two enemies, the cotton worm and the army worm. If they make an attack in force, your crop will be swept away as soon as Jonah's gourd. The army worm is much less insidious in its advance than the cotton moth or cotton caterpillar, and you can arrest the march of the devouring army by a narrow, sharp cut ditch carried all around the place. If you hear of the advancing host from the south or south-west, lose no time in starting your double ploughs in on the side of your field which is threatened. Throw a furrow from the crop, and let the hoe and spade follow, clearing out and cutting down till you have a perpendicular wall of earth, from twelve to eighteen inches high, facing the enemy. Feeble as this earthwork appears to be, it is enough to stop the march. As soon as the advance guard reaches your lands, however, a strict watch must be kept, lest at some point they find a low place in the earthern wall or some means of scaling it. It may be well to keep the double ploughs at hand, in order to deepen and clear out the ditch as they come piling into it.

The caterpillar, cotton worm, or cotton moth, for each of these names is applied to the same animal, appears also in August. You will see a few pale brown millers or moths flitting over the cotton field. By watching, you may observe the insect selecting a leaf for her web or nest. She will generally discover the place of her eggs by cutting the midriff or largest fibre of the leaf, and bending it over so as to form a little shelter tent, so to speak, for her young. The eggs hatch in ten days, and the little worms begin at once to devour the plant upon which they were born. They eat constantly, day and night, growing rapidly to the length of about an inch and a-quarter. The time for fighting this enemy is as soon as you see the first moth. They are clumsy and slow in their flight, so they can be struck down with little paddles and killed. As some will, of course, escape this attack, the planter should look carefully through the rows of his crop for the leaves on which the eggs have been laid.

With a little practice the eye becomes quick at detecting the leaves that have been cut and bent over. These should be carefully gleaned, put into the cotton bags, and burned.

Some have succeeded in protecting a crop by catching the moths in plates, half filled with a mixture of molasses, vinegar, and cobalt, and exposed at numerous points over the field.

Every preventive and each mode of attacking the enemy should be employed. Some have destroyed a great number of these pests by building small fires in different parts of the field, into which they plunge and perish. Others plant white flags about the field, upon which it is thought the fly deposits its eggs.

SEPTEMBER.

If your crop was rescued from the devourers, nothing now remains but to press the picking as actively as possible. The best cotton is gathered in September and October. Provide every facility for your hands, good bags with open mouths, baskets, and a scale or balance that weighs rapidly. Give hot coffee in the morning, especially if you are on low land, encourage fast picking by corresponding wages, and manage to keep them out of the night air. You can ill afford to have hands out of the field now with chill and fever.

OCTOBER.

The best month for picking. It is a remarkable set of hands than can average two hundred pounds all round, yet, among a force of twenty pickers, some will always bring in more than that in open cotton.

Keep the morale of your labourers at a high point. A sad heart makes the motions slow. Hands will not pick any the worse the next day for having danced till ten or eleven o'clock the night before; and, among Africans at least, the best dancer is likely to be the best picker.

Unless your crop is very large, so as to need every finger in your employ to pick it out, the best time for sorting the cotton is when it is first picked. Before November you will not have much inferior cotton. After frost and heavy rains there will be many imperfect bolls that yield a crumpled or kinky staple, and much cotton will be beaten out of the pods by driving rains, and made muddy by earth dashed upon it, or sand driven into it. This can be cleaned so as to be but little inferior to choice cotton, but the two should not be mixed, as the trashy will lower the price of the clean with which the buyer finds it mixed.

Many cotton growers have a "trasher," a simple machine, driven by a band from the drum, which cleans the staple by whipping it against a series of pegs or teeth.

Trashy and dirty cotton ought to be dried and trashed before being stored away for ginning.

NOVEMBER.

As the season grows cool, the picking at night and morning is anthing but pleasant.

Nothing will be gained in the end by gathering in a cold and heavy dew. Let there be fires kindled at the baskets, and in every manner seek the comfort of the hands, for the staple which they are picking now is somewhat inferior, and their encouragement is that the long pull of monotonous and wearisome labour is nearly over. If the market is favourable, ginning is begun this month, and often much earlier. A good eighty-saw gin will pick off less than a bale an hour, say eight bales in ten or twelve hours. But this rapid ginning generally damages the staple, and for that reason is not recommended.

As a rule, it requires as many pickers as there are saws on a cylinder to keep a gin constantly running. Thus seventy-five or eighty pickers will bring in at night as much as the gin will run out the next day. But it is always better to let the cotton remain in the seed a month or more after being picked. The staple is of better colour and weight.

DECEMBER.

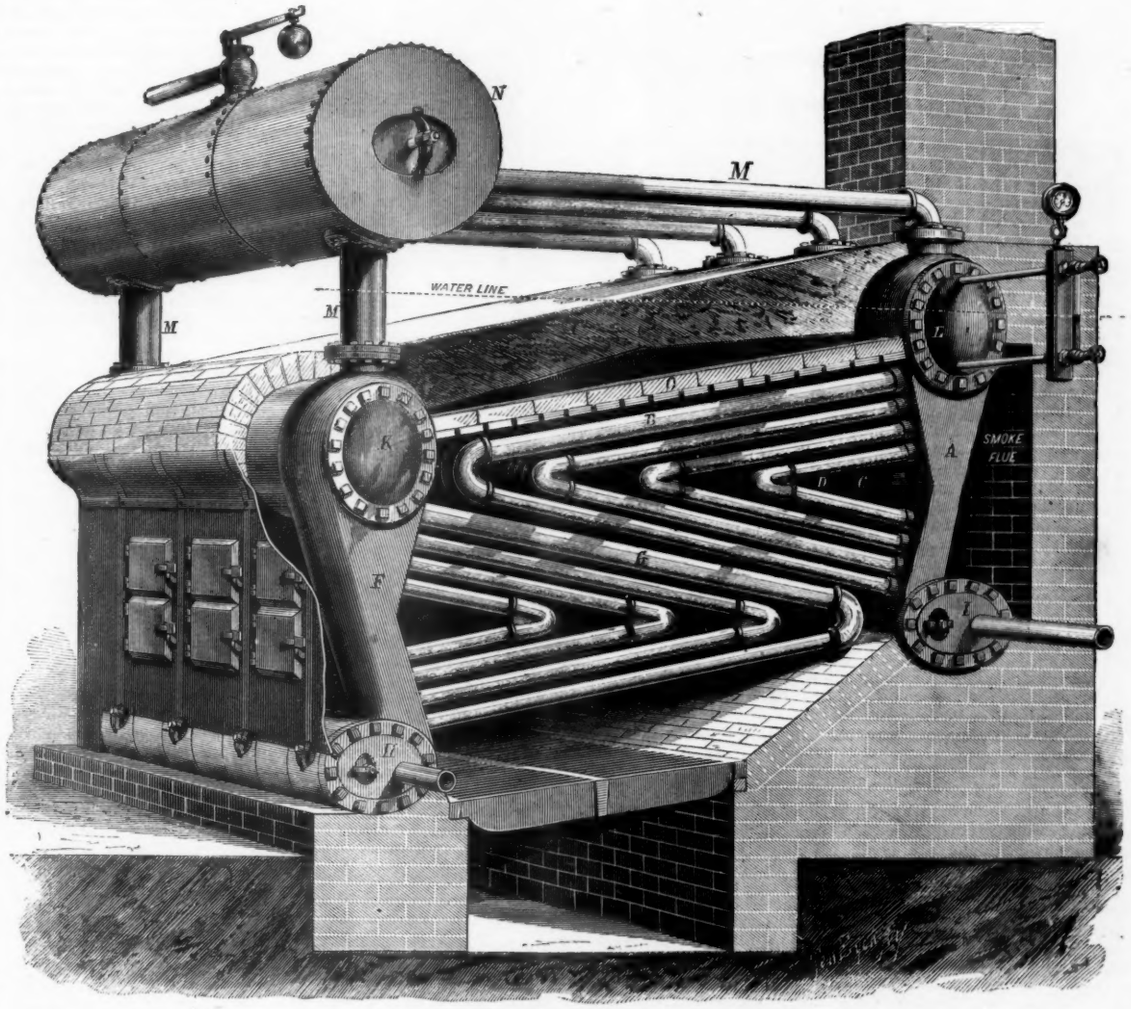
By the middle of this month the cotton is mostly picked. Now the corn and potatoes are gathered, and teams are active in hauling the crop to a market or shipping point. The baling is best done on damp or rainy days, as heat and dryness tend to extract the oil from the fibre. In some parts of the cotton region it is advisable to put a small force to pulling up and burning the stalks as soon as picked, preparatory to another crop.

THE ECLIPSE SECTIONAL STEAM BOILER.

THE "Scientific American" reports—The invention herewith illustrated is a steam boiler composed of a number of separate sections, each by itself comprising all the parts of a complete steam generator. Our engraving represents a double form of the device, so constructed as to economize room and yet afford a large heating surface. The

upright chamber A and <-shaped series of tubes B compose one section; portions of others similarly constructed, placed beside each other so as to form the rear of the apparatus, are shown at C and D. Any required number of sections may be thus located. The chamber F, and tubes G, correspondingly arranged, constitute the first of a series of sections which form the front of the boiler. All the chambers communicate at the tops and bottoms, so as to form continuous mud drums at H and I, and water spaces at K and L, the latter connecting by means of the pipes M with the steam drum N. The sections composing the front portion of the boiler are less in number than those in rear, for the reason that every other one is omitted in order to afford the necessary space for the doors.

Both parts of the apparatus, front and rear, have independent circulations, that in the former commencing in the mud drum H, passing through the tubes G, to the water space K, and thence back; in the latter the circulation commences from the drum I, passes through tubes B, space L, and return, and, being very rapid, prevents the accumulation of scale or sediment in any portion except the mud drums, which may be easily cleaned. The sections have man-holes on both sides, and are held together by short bolts on the inside around these openings. The facing strips are of sufficient thickness to hold the sections apart and to allow the smoke to pass, thus making the entire boiler into heating surface, except the steam drum and bottom of the mud drum. The drums will allow a man to enter and pass through



THE ECLIPSE SECTIONAL STEAM BOILER.

the sections, so that, in any case, should a tube become disabled, it may be replugged without loss in the service of the boiler.

It is claimed that the angular form insures the greatest amount of heating surface, and at the same time allows for the unequal expansion of the tubes. One end of each pipe is screwed into a return bend, and the other is fastened to the chamber by a long thread and lock nuts, making reliable steam joints, which may at any time be loosened if required. The tubes are also so arranged as to be readily cleaned from soot arising from the use of bituminous coal.

The construction of the grate needs no especial reference. The heated air in rising passes around the tubes and out between the back sections into the flue, and thence to the chimney. The roof of the fire-space is lined with fire-brick, above which a layer of any non-conducting material is placed. It is claimed that, owing to the large heating surface, increased rapidity of getting up steam, and a consequent less expenditure of fuel, are effected. We are informed that steam has been obtained from cold water in the space of fifteen minutes.

The water-chambers are large enough to insure a free passage of the water, thus preventing foam and securing dry steam.

These boilers can be readily taken apart for transportation, put together by any engineer without injury to joints, and can be enlarged at will by adding sections. They are constructed double, as shown in the engraving, or single. In the latter case the form is easily understood by imagining the front sections, of the generator represented, to be removed. Corresponding alterations are made in other parts to accord with the single set of tubes

B, and chamber A. The steam drum N is not used, the upper portion L of the sections answering the purpose.

The device in both forms, it is claimed, has been found well suited for high and low pressure, stationary, portable, and marine engines. It is also specially constructed for heating purposes.

We see by the Pittsburgh papers that Messrs. Jones and Laughlins, proprietors of the American Iron Works, have contracted with the Eclipse Steam Manufacturing Company for three large batteries of these sectional safety steam generators, of 240-horse power, to take the place of the four flue boilers which exploded on February 3. They have had a number of sections in use for a year, on trial.

NOTES FROM THE NORTH OF EUROPE.

Preservation of Yeast.

A PATENT for this purpose has been taken out by Jeversen and Boldt, of Copenhagen. The raw yeast is carefully washed with cold water, afterwards the greater part of the water is removed by pressure; a further proportion is got rid of by means of a centrifugal apparatus. But as the yeast cannot be got perfectly dry in this way, it is afterwards placed for that purpose in an apparatus in which a vacuum, or rarefaction of the air nearly approaching a vacuum, can be obtained.

In this chamber the moisture, still combined with the yeast, evaporates at a very low degree of heat, and the vapour formed is immediately absorbed by hygroscopic substances introduced for the purpose—as, for example, chloride of lime. The yeast is finally exposed to a current of air in its ordinary state or dried, or of carbonic acid gas, according to the prevailing temperature and other circumstances. Through these manipulations a perfectly dry powder is finally obtained, which, being hermetically sealed in glass or tin cases, will keep perfectly well for several months.

When required to be used the powder is mixed with water to the consistency of a thin paste, which acts in the same way as fresh yeast.

The Manufacture of Wood Oil.

From the "Norden."

A large number of manufacturers held meetings this year at Stockholm; a report having now been printed we gather the following from it:—

Various statements were made by thirty-nine manufacturers, from which it appears that the preparation of wood-oil as a subordinate branch of forestic industry, has of late years been taken up with very great interest in the forest districts.

On the same occasion it was determined to form a company called the Swedish Wood-Oil Association, the purpose of which should be to form a union between Swedish wood-oil manufacturers and tar-burners, so as to bring about oneness in the manufacture, and to procure a good rule for the produce of the various manufactories scattered about the country, by bringing them all in contact with the large markets, beyond which the company is intended to labour generally for the continuous development of the industry which aims at turning to account the roots of fir trees. The share-capital is to be not less than 40,000 riksdalers (£2,200), nor more than 400,000 riksdalers (£22,200), each share being for 200 riksdalers (£11).

The reported proceedings further show that the branch of industry in question has still to contend with many and various difficulties, and especially that it is very troublesome to get the raw oil sufficiently purified, so that it shall possess the properties required in turpentine and be available for trade purposes, especially for varnish-making, and thus be in request in the general market.

It was held that the best way to avoid this stumbling-block was to make dry distillation and the purification of the articles, thus produced, a separate branch from the manufacture of crude oil or wood-distillation. The latter might go on as a subordinate branch of forest industry, and would certainly, if carried on judiciously, yield good results, especially if the refineries, which ought then to be carried on on a large scale, were so situate as to permit of easy carriage to them from the crude oil works.

Another proposal to arrange the whole of the trade on such bases was brought before the meeting, but so late that it could not come on for discussion.

The Drammen Exhibition.

Whilst the attention of all Europe has been directed to the great exhibition in the capital of Austria, one of the large towns of Norway, Drammen, has ventured, at the same time, to invite general attention to a Norwegian Exhibition of the production of handicrafts, manufactories, and domestic industry; hardly with any hope of numerous visitors from the rest of Europe, or of exciting any special and general interest, but still with the consciousness that this is the first industrial exhibition held in the country.

Such is the case; and it must be admitted that Drammen, from its connection by the new railways with the best parts of the interior and the capital, has a favourable central situation both for trade and manufactures; and that the town, on this occasion, has not failed to avail itself of its favourable position to collect, from the most varied and remote parts of the country, a large number of interesting objects, characteristic of the industrial position of the land. We will not go into any detailed description of the contents of the Exhibition, as this probably would not possess much interest for readers abroad. We simply name, in passing, that the Exhibition shows the beginnings of various branches of industry in this country, which, in the course of time, will probably expand and prove of interest, not only to this, but other lands. Considered as a whole, the Exhibition is calculated to give the impression that we in time shall derive the greatest advantage from our numerous waterfalls, especially if the high prices of coal continue; for example, our mills are already in a position to compete with foreign manufacturers in the production of woollen and cotton goods, but they have hitherto had to limit their sale to the home market.

The last Storting (the Norwegian Parliament) passed a considerable reduction of duty on cotton, linen, and woollen goods; several articles were thus made almost free of duty, but our mills consider themselves, nevertheless, fully capable of competing with foreign makes in the home-market, and they even hope to be able in a short time to compete successfully with other countries in the markets abroad.

Our manufacture of glass and pottery is making steady progress, and the export of glass is no longer inconsiderable. Hitherto we have not derived so great an advantage from our fisheries as we should have done, and large quantities of useful materials have been thrown away in waste; in this respect there is a gratifying change for the better; the manufacture of train oil and guano having considerably increased.

The Exhibition has made Drammen the central town for all travellers in Norway this summer, and the number of visitors has been very large.

One gratifying circumstance has been that most of the manufactories and large establishments within a practicable distance of the Exhibition, have made arrangements for their workpeople to have an opportunity of examining this friendly competition in the arts of peace. And it is very probable that the many thousands of plain working men, who in this way have seen the Exhibition, have been among its best visitors, and have contemplated the objects exhibited with the greatest attention and interest.

THE TRADE OF THE RHENISH PROVINCES.[1]

IT is characteristic of the district of which Düsseldorf is the centre that it comprises, in a comparatively small space, every sort of manufacture to which human ingenuity is applied, whilst it furnishes in ample quantities the raw material from which machinery and the motive power of machinery are derived. Coals and iron abound; and the skill and patient labour of an active people are exercised with equal assiduity in taking from the earth its hidden treasures and forming them into material for further use. Interchange is favoured by the current of a river, the navigation of which is secure for ten or eleven months of the year, and a net of railways only comparable in extent to that of Belgium or Great Britain. The rapid growth of industry is copiously demonstrated by density of population and abundant wealth; but the true proportions of progress are more surely brought home to our understanding by

[1] Report by Consul-General Crowe on the trade of the Rhenish Provinces for the year 1872.

LA SEINE.—EPERGNE FROM THE HOTEL DE VILLE, PARIS, BY CHRISTOFLE AND CO

the statement of a few facts showing the natural riches of the land and the energy of its inhabitants.

In 1855 the total yield of the coal mines of Westphalia, exclusive of those on the left bank of the Rhine, did not exceed 3,000,000 tons; in 1871 it had risen to 13,000,000; and this result is equal to that which was achieved in Belgium between 1836 and 1871. The quantity of iron ore raised in the mining districts of Dortmund and Bonn was about 1,000,000 tons in 1864; 2,125,000 in 1871.[1] In 1855 there were 133 blast-furnaces, producing 216,583 tons of pig-iron; in 1871 there were 146 furnaces, yielding 882,373 tons. The goods traffic of the Cöln-Minden and Rhenish railways was £1,195,833 in 1864; £2,089,871 in 1871. The transit of goods on the Rhine at the Dutch frontier port of Lobitz was 24,000,000 centners in 1864 and 40,500,000 in 1871.

This flattering picture of prosperity is dimmed by one cloud. Little more than five years have elapsed since the first strike took place in the Rhenish Provinces. Labour till then had been comparatively cheap. It subsequently rose in price so as to command at last a sum only equalled in Great Britain or France. Yet, with regard to the labour market, there is one important fact to be noticed. In England wages greatly increased in amount; but short time and small application of the working man diminished individual production. Had these evils been confined to Great Britain, we might fear the disastrous effects attributable to the competition of German industry with English laziness; but the same evils are apparent on the Rhine, and *pro tanto*, the relative position of the two countries remains the same.

It is said, and there can be no doubt of the fact, that the production of coals and iron in the Rhenish Province and Westphalia is lower than it should be, considering the mineral wealth of the soil. The causes of this backwardness have been exhaustively stated by a person of acknowledged authority on the subject,[2] and they are shortly these:—1. The hindrances created by an incomplete organization and expansion of railways; 2, the cost of transport and the manner in which rates of carriage are charged; 3, the distance which separates the ores from the furnaces and the rolling mills from the outports.

It is the misfortune or the fault of the railway companies that they cannot without great exertion carry the goods that are offered to them by the public; and it is evidence of this difficulty that an accident which blocked up one of the lines of the Bergisch-Märkisch Company for twelve hours in 1871, caused a deadlock at all the stations, and kept the traffic in confusion for weeks. Level crossings of rails across each other or across frequented highways and streets; stations with small shunting space, short rolling-stock, single lines, low speed, the absence of running powers for goods over the territory of more than one company, are some of the acknowledged causes of this state of things. The want of through trains for certain classes of articles, the neglect of through rates for goods carried to important centres at long distances away, and the high charge for transport of raw material, are impediments which directors and shareholders probably hesitate to remove till they see their way to work increased traffic with comfort or freedom from accidents. Coals alone are taken in some cases at the rate of 1 pf. per centner (2*d.* per ton) per German mile;[3] but the local rate for coals, ores, and iron, varies from 1½ to 2½ pf. per centner (3*d.* to 5*d.* per ton) per German mile.

Iron ore is found in hilly districts, often without railway communication, frequently without roads; the modes of extraction are primitive, the capital employed small, cheap labour is more than counterbalanced by cost of carriage. A glance at a map will show how many miles separate the blast-furnaces of the Lower Rhine, the Ruhr, or the Emscher valleys from the iron mines of the districts Aix-la-Chapelle, Hesse-Darmstadt, Hesse-Cassel, Nassau, or Hanover. The distance is such that masses of ores which contain small percentages of metal are unused, and those only are set apart for transport which contain a maximum of iron. Even in places which are favoured by railway communication, the price of transport is a most important item in the expense of production; and this is a point of such paramount interest that it deserves to be illustrated by at least one example.

Siegen, in Westphalia, is in the centre of a district containing fifty-two iron mines, yielding (1871) over a quarter of a million of tons of ore. Siegen is in communication with the Lower Rhine by the Cöln-Giessen line, and with the Ruhr by the railway which runs through Iserlohn and Hagen to Bochum, Essen, and Ruhrort. Raw spath ironstone or specular hematite (Eisenglanz), worth 22*s.* to 24*s.* a ton at Siegen, costs 25*s.* 6*d.* and 27*s.* 6*d.* at Essen, the carriage amounting in each case to 3*s.* 6*d.* per ton for about seventy English miles. At Dortmund, Ruhrort, or Duisburg, the Siegen ores are dearer than at Essen in proportion as those places are more distant from Siegen. It was calculated in 1868 that, taken in conjunction with charges of similar amount for the carriage of limestone, and adding the price of both limestone and ores to the amount, 35 to 50 per cent. of the total cost of production of iron would be made up—iron of good quality indeed, but often sold at a nominal profit. If, under these circumstances, the railway rates for carrying iron were as low as they might be, Rhenish bars might compete with English in the Dutch market; whereas, at present, there are insurmountable impediments to this in the high cost of production and the freight of 5*d.* per ton per German mile which the railway companies impose. The companies may in time acquire the certainty that real benefits would attend an equalization of rates for ores, coals, and iron. The differential tariff which rules at present makes it cheaper to send ores to the collieries than coals to the iron mines,[1] because, *e.g.* the carriage of iron from Siegen is dearer than that of coals to the Siegen furnaces. Through rates, again, from points in Westphalia to Rotterdam, may, when introduced, give a more general extension to a business oppressed at present by mileage and booking charges.

Under its present difficulties, the mineral trade of the Rhine Province and Westphalia has been materially checked. I stated the increase of production from 1,000,000 in 1864 to 2,500,000 in 1871. The traffic returns of the principal Rhenish lines show that the railway companies have almost a monopoly of the carriage. The number of tons transported by Cöln-Minden was 530,684 in 1865, and 666,293 in 1870; by Bergisch-Märkisch, 250,000 in 1865 and 541,680 in 1870; by Rhenish, 100,000 and 126,875. In competition with locomotive power, the waterway of the Rhine lags sorely behind, creating expenses for sheds, agencies, and trans-shipment; yet the port of Oberlahnstein forwarded as much as 230,000 tons of ores in 1871.

Quotations of ores show how largely the local demand of late years enhanced prices. Spath-ironstone (raw) cost 17*s.* 4*d.* per ton at Siegen in 1871; it was worth 22*s.* 6*d.* to 24*s.* per ton at the close of 1872. Hematite (Eisenglanz), which was quoted at 21*s.* 7*d.* in 1871, was not to be had under 24*s.* per ton in 1872. We test the supply of foreign ores to the Rhenish Provinces to some extent by the returns of the Dutch custom-house at Lobith on the Rhine, where 19,719 tons passed up-stream in 1867 and 29,697 in 1871.

Of more interest than the business in ores, the coal trade has features of its own which attract peculiar attention. The large expansion of production between 1855 and 1870 was accompanied by an extraordinary increase in the number of hands employed, whilst the area over which the coals were distributed, and the price at which they were sold, underwent a curious and gradual diminution. With one exception, the same phenomena were apparent from 1870 to 1872. A larger extent of the coalfields was opened out, more coals were produced, and more workmen were employed; but prices rose, and the rapid hardening of quotations gave to the trade an abnormal aspect. The causes of these changes can only be traced minutely with the help of numerous tables; but I may state generally, 1, that the coalfields were found to be much more extensive than was supposed; 2, that the opening of new collieries produced the discovery of rich seams of steam, gas, and coking coal; 3, that the gradual extension of railway communication opened up local markets for coal for manufacturing and domestic purposes; 4, that manufacturing power was favoured and developed in the Rhenish Provinces by the political consolidation of the country and a liberal commercial policy; 5, that cheap rates for carrying coals to long distances were rapidly introduced; 6, that a law, passed in 1867, abolished all restraints upon the free migration of labour; 7, that the coal royalty was reduced from 6 to 2 per cent. of the total yield of the collieries; 8, that a generous alteration was made in the spirit of the mining laws, which had hitherto crippled individual enterprise; and 9, that German transatlantic navigation was successfully brought into existence.

Some of these causes were naturally more powerful in their effects than others; but the result which they all tended to produce was a colossal enterprise, the aim and purpose of which was to supply the home and foreign demand for every sort of manufactures. In pursuance of this aim, the manufacturers used

[1] The quantity of iron ores raised in Great Britain in 1871 is officially stated to have been over 16,000,000 tons.

[2] "Memorandum on the Progress of the Coal and Iron Trade in Germany," by W. T. Mulvany, 1868.

[3] The German mile, at a rough computation, is equal to 4¾ English miles.

[1] See Mr. Mulvany's Memorandum, *ante*. But these calculations and statements must be revised, since (January 1, 1873) the Bergisch-Märkisch and Rhenish lines have agreed to carry coals, ores, and iron in local trains at 2*d.* per ton per German mile, with a station charge, once levied, of 1*s.* 2½*d.* per ton in addition.

more coals than they had ever required before, and their wants became so pressing at last as to absorb a great part of the yield of the collieries, to narrow the area of exportation, and to enhance prices.

The efforts which were made by the coalowners to satisfy the home demand, and at the same time to increase their exports, were impeded by uncommon obstacles. The mining population proved too small, the railway accommodation too short, for the occasion. New lines in preparation were but slowly made and partially opened; and traffic rates remained unchanged, in order to keep down, if possible, the strain upon the companies' rolling-stock. Miners asked for, and received, higher wages, until such time as their claims exceeded the limits considered fair by the masters. They struck and threw the trade into temporary confusion. Some peculiar features in the relations of masters and men I may advert to presently.

Twice within ten years the coal trade was surprised and checked by war. In 1866, when the prospects of the ironmasters were so brilliant as to suggest the most flattering hopes, war broke out between Austria and Prussia, and produced a long period of anxiety and stagnation. In 1869 and 1870, when the iron trade again showed symptoms of revival, both coalowners and ironmasters seemed on the eve of realizing great profits, when hostilities with France broke out. Contracts for the delivery of coal, easily entered into in 1869 at 5*s.* 9*d.* to 6*s.* per ton, were only renewed in June, 1870, at 7*s.* 6*d.* to 9*s.* "So large a demand, coupled with high and rapidly-increasing prices, had not been known for fifteen years;" purchasers had never offered to buy so freely or for such long intervals of time. No summons to arms ever marred a fairer prospect of commercial activity. The concentration of carrying power by rail on military transports, the drain of labour at the collieries, forced the coalowners to curtail their work; "and it actually occurred that English coals were imported into Cologne for the manufacture of gas."[1] Though war was still being carried on in the early part of 1871, there were clear prospects of peace in spring, and coal was soon at such a premium as to tax the working power of collieries and railways to the utmost. In spite of scarcity of labour and transport, the yield and the sale of coal increased, though not in the proportion in which they might have increased had the collieries been able to extract and the railways to carry more. As it happened, the transport accommodation was insufficient to prevent accumulation at the pits' mouths or emptying of coal-yards at smelting and rolling works; and many of the latter stood comparatively still, whilst some of the former blew out their furnaces. In May, 1872, the trade was buoyant: wages were rising; but the large dividends paid by several collieries excited the cupidity of the miners, who struck on the 18th of June in the district of Essen to the number of 15,000 to 20,000 men.

It is necessary, in order to understand the real bearing of this strike, to distinguish the prices quoted for the public from those at which collieries under long contracts were making their deliveries. The public and contract prices differed according to date as follows:—

Year and Month.	Public and Dealers' Prices per Ton.[2]		Contract Prices, per Ton.	
	s. *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*
1870. January . .	5 8 to 6	0	—	—
September .	7 5	9 0	5 8 to 6	0
1871. January . .	7 5	9 0	6 0	7 0
September .	9 0	9 10	7 0	8 0
1872. January . .	12 0	13 0	8 0	10 6
May	13 0	14 0	9 6	11 2

The market for coal and iron is peculiar in this, that coalowners and ironmasters work to order and not for stock. The strike was based on high public quotations for coals, which were essentially at variance with those registered for contracts at the collieries. It might be evidence of the primitive barbarism of strikes that the colliers were standing out for wages calculated upon prices from which the coalowners were deriving no advantage at the time; but the real cause of the movement amongst the men was equally independent of the value of coals and the amount of wages. It was got up by outsiders, who took advantage of the rising tendency in the labour market to promote the substitution of fixed wages for piece-work and a reduction of time. The miners' claims were these—1, 25 per cent. more wages all round; 2, a normal hiring of 4*s.* per shift as a minimum in wet or dangerous seams; 3, eight hours' shift above and below ground, including the time of going up and down, in place of eight clear hours below and ten hours above; 4, dispensation of hewers from loading; 5, 3*d.* per cwt. for house coal.

To these claims the masters made a determined resistance, declaring their firm intention to refuse all arbitration or communication with outsiders, and to treat with their men only. They maintained that the system of shifts in actual practice was a proper and just one, that the earnings of miners had been rising for a considerable time in a manner proportioned to the expansion of industry throughout the country, and that the wages were the best in any trade in Germany. I visited several collieries, and was kindly furnished with detailed statistics, from which much instruction may be derived in regard to the points urged by masters and men.

That during a succession of years and of months up to the period of the strike mining wages improved is conclusively shown by the following table, which gives the earnings of hewers and putters in several collieries, three of which, Anna and Carl (belonging to the Cologne Mining Union), and Hibernia, near Gelsenkirchen, were within the compass of the strike:—

Year and Month.	Hibernia.		Anna.		Carl.		Erin.		Hansa.	
	Hewers.	Putters.	Hewers.	Putters.	Hewers.	Putters.	Hewers.	Putters.	Hewers.	Putters.
	s. *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*
1863 .	2 6	2 1	—	—	—	—	—	—	—	—
1864 .	2 9	2 2	—	—	—	—	—	—	—	—
1868 .	3 0	2 4	—	—	—	—	—	—	—	—
1869 .	2 2	2 6½	3 6½	2 2	2 11½	2 3	—	—	—	—
1870 .	3 3½	2 9	3 4	2 5½	3 3½	2 6	—	—	—	—
1871 .	3 7	3 1	3 6	2 6½	3 5½	2 8½	3 6	—	4 4	—
1872 .	—	—	—	—	—	—	—	—	—	—
Jan. .	4 0	2 5½	3 6	2 8¼	3 7	2 8½	3 7½	2 10	4 4	2 10
Feb. .	4 1	2 5½	3 9	2 9	3 10¼	2 11	4 0	3 1	3 11	2 11
March	4 2½	2 5½	3 10¼	2 10	4 1	2 10	4 1½	3 4	3 11	2 10
April .	4 3½	2 2½	4 1	2 10½	4 1	2 11¼	5 4	3 2	3 10	2 9
May .	—	—	4 0¾	2 9¾	4 0¼	2 11½	5 10	3 4½	3 9	2 10

The wages per tub vary in all the collieries. I have ascertained, with respect to two of them, the following,—Hansa yielding hard, but light-weighing steam and gas coal, and Erin a softer, heavier coking and mixed coal:—

Year and Month.	Erin. Wages per Tub.	Hansa. Wages per Tub.
	Silbergroschen.	Silbergroschen.
1871. January . . .	—	—
February . . .	4·32	7·20
March . . .	4·23	8·00
April . . .	4·44	7·00
May . . .	4·54	7·10
June	4·43	7·00
July	4·60	7·50
August . . .	4·73	7·00
September . .	4·50	7·00
October . . .	4·95	7·90
November . .	5·22	7·50
December . .	5·84	7·90
1872. January . . .	5·53	8·10
February . . .	4·95	8·30
March . . .	6·82	7·30
April . . .	—	8·00

As wages rose, the day's labour of the miner fell in value. To use a technical expression, the "effect" diminished as wages increased. Thus in 1866, the annual product of one man's work at the collieries of the Rhenish Provinces was 227, whilst in 1871 it was but 215 tons. More coal was raised in 1871 in the district of Dortmund by 7½ per cent. than in 1870; but the number of workmen in 1871 was superior to that of 1870 by 22·38 per cent.[1] A valuable technical report[2] attributes this falling off of the effect in 1871 to the fact that, during the war and after its close, a large number of men found employment in mines who knew little of mining. It dwells on the known fact that "want of transport often stopped the working of collieries;" but the cause lies deeper, and it is notorious that high wages have not promoted close application to work in mines. In some of the collieries of which I have given statistics, the wages of Englishmen contribute somewhat to the high average of monthly earnings. I am enabled to compare as follows the "effect" of English and German hewers in the Hansa colliery:—

[1] Memorandum of July, 1870, by Mr. W. T. Mulvany.

[2] To these wholesale prices I may add the retail quotations for coal, which were in October, 1872, at Düsseldorf, 19*s.* 3*d.*, in November, 21*s.* 7*d.* per ton.

[1] This statement is official, and comes from Ober-Bergrath Wagner, in Dortmund.

[2] "Jahresbericht des Vereins für die bergbaulichen Interessen in Oberbergamtsbezirk Dortmund für 1871."

Year and Month.	Germans.		English.	
	Tubs per Shift.	Earnings per Shift.	Tubs per Shift.	Earnings per Shift.
		Silbergroschen.[1]		Silbergroschen.
1871. January .	5·2	34·3	6·8	44·8
February.	4·3	30·9	5·7	58·7
March .	3·8	30·7	5·1	53·5
April .	4·0	28·3	5·5	56·6
May .	4·2	30·1	5·7	65·5
June .	4·6	32·2	6·1	65·2
July. .	4·6	34·9	6·5	71·5
August .	4·7	32·9	6·0	63·5
September	4·7	33·6	5·6	56·5
October .	4·8	38·0	6·0	58·0
November	4·8	36·1	7·3	58·4
December	4·4	34·8	7·0	60·9
1872. January .	4·5	36·8	6·6	60·4
February.	4·2	35·1	9·9	80·7
March .	5·1	38·7	8·4	78·9
April .	4·1	33·0	6·5	61·7

An average of 4·4 tubs and 3*s.* 3*d.* per shift for Germans, compared with 6·0 tubs and 5*s.* 11*d.* per shift for Englishmen, affords a striking example of the greater power which English feeding gives to English colliers;[2] but the earnings of Germans sometimes come near those of our countrymen; and the masters in June of last year published the wages of the chairman of the strike,—a German hewer in the Tremonia colliery,—as having been £5 to £7 a month, and those of one of his colleagues as £6 9*s.* for 25 shifts = 5*s.* 2*d.* per shift.

I am not inclined to deny, considering the state of the labour market, that the colliers might have been justified in striking for higher wages, though I think that a strike is truly described as a barbarous expedient; but I believe and repeat that the aim of the movement at Essen was not a mere advance in wages, but the introduction of a principle which has the support of a well-known and overrated party, that a day's work is worth the same hire, whether it be good or bad. Against this principle an Englishman (or more correctly an Irishman), Mr. W. T. Mulvany, to whom Rhenish industry owes much of its development, thought it his duty to protest; and in an address which was widely circulated on the 21st of June, he urged with habitual force the various arguments which confute this pernicious doctrine. "Some men," he said, "are strong, talented, energetic, experienced, honest, sober; others are weak, stupid, slow; are they all to be put on the same footing? The full value of the work of each individual can only be fixed at a market price by the universal law of demand and supply; but this must be done without interference from third parties, and without compulsion. Strikes are like a two-edged sword, which nearly always injures first and most dangerously those who use it. It instantly stops the earning of wages, and often proves that there is no want, but rather a superfluity, which reveals the wages were not too low. The circumstances of every colliery and of every seam in a colliery are such as to require a different bargain in each case, and different arrangements for hewers and putters. A normal hiring under such circumstances is absurd; but it is clear that such bargains cannot be the same with a good or an indifferent workman. When such bargains are made," Mr. Mulvany concludes, "a system of premiums should be established for regular attendance, and for those who make upon them the highest wages per month."

In the last of these sentences a question is raised which suggests grave reflections. It is the habit of some persons to say that a workman ought to have an interest in the profits of the concern in which he labours. But surely the profits of a man's labour are his wages. A miner or an operative who should ask to receive a share of profits would necessarily be required to bear some of the risks, and this, it is notorious, he cannot do. Another proposal, and one which commends itself to our attention, is this: Let the workman have a premium at the end of the year; let that premium be generously measured, say at not less than 10 per cent. per annum on his year's earnings. Let it be understood that this favour will be forfeited by misconduct or by breach of contract. Such an arrangement might be made an admirable instrument for facilitating the relations of masters and men.

A few days after the appearance of Mr. Mulvany's address, a German of great experience in this country, and now not unknown to the world at large, Mr. Krupp, spoke to his men in the following firm and energetic language:—"Forty-five years ago when I stood on the foundations of these works, the daily wages of my small array of smiths and smelters were raised from 18 stüber to 7½ sgr. (9*d.*). The week's pay was 1½ th. (4*s.* 6*d.*). During fifteen years I earned as much as proved sufficient for my living and no more. As circumstances changed and the works expanded, I gradually raised the rate of wages (as I am doing now) without compulsion or advice. Improvements have been made, and are still being made; my best efforts have been used in the interests of my men; thousands have been spent, and are still being spent, in lodgings. An honest and industrious mechanic in my establishment has the prospect of retiring after a certain period to his own cottage, where he may pass the rest of his days in the enjoyment of a moderate pension. I shall refuse every unjust demand, and I claim from every person who is dissatisfied that he shall give me instant notice if he wishes to forestall my giving notice to him, with the assurance that I mean to be master in my own house and on my own ground."

I might enlarge here on a point which was touched upon by Mr. Krupp. I might show that the colliery country is dotted with cottages, sometimes built by the colliers themselves on their own rood of land, more frequently owned by the masters, and either let at a yearly rent or given in possession for ever on conditions settled beforehand and extending over years. I might show that where cottage accommodation is given, strikes are less liable to occur; that the dwellings of the miners in the Essen district are worse, the conditions of the holdings less favourable, than elsewhere. But I want precise details on those points at present. I might show the advantage that accrues to the miners from the forced contribution to sick and pension funds; but this inquiry would lead me too far, and I turn in preference to another question intimately connected with strikes and with the welfare of the labouring population generally.[1]

The steady, progressive rise of the price of provisions has been stated to have been one of the facts justifying the Essen strike. I shall test this question by comparing the price of necessaries at Essen and Bochum, the two largest towns within the area of the colliers' strike:—

TABLE SHOWING THE AVERAGE PRICE OF NECESSARIES AT ESSEN DURING THE YEARS 1868 TO 1872.

Years.	Wheat per 200 lbs.	Rye per 200 lbs.	Barley per 200 lbs.	Potatoes per 200 lbs.	Peas per 200 lbs.	Brandy per Prussian quart.	Beer per Prussian quart.	Meat per lb.				Butter per lb.	Eggs per quarter hundred.	Rice per lb.	Salt per cwt.	Coffee, burnt, per lb.
								Beef.	Veal.	Mutton.	Pork.					
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1868 . .	1 7 5	1 2 4	1 3 5	0 7 0¼	1 6 1½	1 2	0 3	0 6¼	0 4½	0 5	0 9	1 0¾	1 3½	0 3¼	8 5	—
1869 . .	1 1 9½	0 19 1¾	1 0 0¼	0 6 2	1 2 11½	1 1¾	0 2¾	—	0 4¾	0 5¾	0 9¾	1 1½	1 4	0 3	8 4	—
1870 . .	1 2 0¼	0 19 3¼	0 19 7	0 8 0	1 3 5	1 2	0 3	0 6¼	0 4¾	0 5¾	0 9¾	1 1½	1 5	0 3¼	8 5	—
1871 . .	1 6 2	1 0 4	1 1 10½	0 9 0¾	1 5 6	1 1¾	0 3	0 6½	0 5¾	0 6	0 9½	1 3	1 4½	0 4	8 5	1 4
1872 . .	1 6 0¼	1 0 1	1 2 4	0 8 9	1 5 5	1 1	0 2¾	0 6½	0 5	0 5½	0 9¾	1 2¾	1 7	0 3¼	8 5	1 3

[1] 1 silbergroschen = 1¼*d.*

[2] It is also to be borne in mind that German miners, as a rule, do not live at the collieries. They walk miles (sometimes as many as five miles) to and from their work, and are frequently tired before they go down into the pits. Yet a German coalowner has said that if he could feed a German collier as an Englishman feeds, he would get the same work out of him. English colliers here are provided with lodging at the collieries, and preserve in a foreign country all the habits of Englishmen, even when they marry German wives.

[1] I may note that no strike took place at Krupp's.

TABLE SHOWING THE AVERAGE PRICE OF NECESSARIES IN THE TOWN OF BOCHUM, NEAR ESSEN, DURING TWELVE YEARS.

Years.	Wheat per Imperial Quarter.[1]	Rye per Imperial Quarter.	Barley per Imperial Quarter.	Peas per Imperial Quarter.	Potatoes per Bushel (English).	Wheaten Roll per Roll.	Rye Bread per lb.	Beef per lb.	Veal per lb.	Pork per lb.	Bacon. per lb.	Butter per lb.	Brandy per Prussian Quart.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1860 .	2 11 9	2 0 1	1 12 0	2 15 5½	2 3¾	0 0⅞	0 0 7/10	0 4½	0 4	0 7¾	0 7¼	0 9¼	0 6¼
1861 .	2 14 0	1 16 7½	1 13 0¼	2 19 1½	2 9	0 0⅞	0 1 1/10	0 5¾	0 4	0 7¾	0 7¼	0 10¼	0 9¼
1862 .	2 14 0	1 19 8	1 11 0¾	2 15 6½	2 4¼	0 0⅞	0 1 1/10	9 5¾	0 3¾	0 7¼	0 8	0 11½	0 9½
1863 .	...	...	...	...	...	...	...	...	...	...	...	...	...
1864 .	2 3 9	1 10 4	1 8 1½	2 6 11¼	1 11¼	0 0⅞	0 0 9/10	0 4¾	0 3¼	0 6¼	0 7⅛	0 11½	0 9¼
1865 .	1 15 4	1 9 7½	1 6 2	2 7 1¼	1 10	0 0⅞	0 0 9/10	0 5½	0 4	0 6 1/10	0 6¼	1 0¼	0 9¼
1866 .	2 6 5⅓	1 12 2	1 9 5	2 6 3	1 8⅓	0 0⅞	0 0 9/10	0 6	0 3 9/10	0 6 1/10	0 8¼	1 0¼	0 9¼
1867 .	2 17 5	2 1 2	1 13 8	2 10 4	2 7¼	0 0⅞	0 1 1/10	0 6⅛	0 3 9/10	0 7½	0 8¼	0 11½	0 9¼
1868 .	3 0 4	2 6 9	1 16 7	3 2 0	2 2	0 0⅛	0 1 7/10	0 6⅛	0 4¼	0 7¼	0 9¼	1 0¼	0 9¼
1869 .	2 5 4	1 19 8	1 13 10	2 19 9	1 11	0 0⅞	0 1½	0 6	0 4¼	0 7¼	0 9¼	1 1	0 9½
1870 .	2 10 8	2 0 2	1 13 0	2 11 9¾	2 8	0 0⅞	0 1½	0 6⅞	0 5	0 7¼	0 9¼	1 1½	0 7¼
1871 .	2 17 2	2 0 3	1 13 9	3 1 9	2 10½	0 0½	0 1⅝	0 6⅞	0 5	0 7½	0 9¼	1 2	0 7¼

It would be easy to prove from these tables that corn of all sorts was dearer in 1868 than in 1871 ; but 1868 was remarkable for the shortness of its harvest, and it is to be considered quite as an exceptional year. The prices of 1869 were normal. They are lower all round than those of 1871, and there is no doubt of the truth of the statement that prices rose considerably during the period which preceded the strike. But if we compare the rise in prices with the rise in wages, which equally marked the years under notice, we must come to the conclusion that the workmen had discounted the first before the strike took place.

After the lapse of six weeks, during which the whole body of colliers lost about £3,000 per day, the patience of the men became exhausted, and work was resumed with a will. The natural law of demand and supply soon brought on a further advance of wages ; and normal hiring, or eight hours' shifts above ground, were no longer claimed by any one. The panic which the strike produced as it broke out had had the effect of raising coal prices. Manufacturers clutched at every opportunity of replenishing their stocks, not knowing when the trade might resume its natural level, and quotations were thus brought up to 13*s.* and 14*s.* 6*d.* per ton. In July the demand was heavier than ever, the railways showing less ability to cope with the coal-traffic, and their customers clamouring for contract time without success. Prices thus continued rising, till they came to be quoted 17*s.* and 19*s.* per ton in the open market, and 11*s.* 3*d.* and 13*s.* for contract delivery. As prices rose wages increased, and the progress of these I note in a table :—

Month.	Anna.		Carl.		Erin.		Hansa.	
	Hewers, per shift.	Putters, per shift.	Hewers, per shift.	Putters, per shift.	Hewers, per shift.	Putters, per shift.	Hewers, per shift.	Putters, per shift.
1872.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
May .	4 0¾	2 9½	4 0½	2 11½	5 10	3 4½	3 9	2 10
June .	4 1	2 11¼	3 11	2 11½	5 9½	3 1½	3 6	2 9
July .	4 2½	2 7	4 1½	2 11¾	5 0	3 2¼	3 9½	2 9½
August .	4 5	2 11¼	4 5½	3 2	5 10	3 2	3 9	2 11
September	4 3	2 10	4 8	3 3	5 2½	3 1¾	3 9½	2 11
October .	4 3¾	3 1¾	4 6	3 0¾	5 2½	3 2½	4 7¾	3 0
November	4 3	2 11	4 6¾	3 3¾	5 2½	3 2½	3 11	2 10½
December	4 5	3 9	4 9	3 3	5 2½	3 2¾	3 11	2 10½

I have said that the pressure of the home demand narrowed the area of exportation. This result was apparent at an early period, and was almost as marked in 1872 as in 1871. In 1871, when the yield of the collieries rose from 12,360,746 to 13,568,943 tons, the export of coal down the Rhine fell from 847,451 to 745,443 tons.[2] In 1872 it increased so slightly as to be in no true proportion to the large yield of the collieries. It is not as yet, indeed, clear how much coal was taken down the Rhine in the year that has just expired, but the total export from Ruhrort up and down the Rhine during the first eleven months was 1,075,825 tons, against 1,019,372 tons in the corresponding period of 1871 ; and this small increase is the more remarkable, as the scarcity and dearness of fuel in England produced offers for Rhenish coals from Great Britain, and the deliveries from the Westphalian collieries hardly fell short of 14,500,000 tons. In truth, the wants of the Germans were so great that, in spite of high prices, they could bid securely for all that the coalowners produced, and the eagerness which they displayed naturally kept back more distant buyers.

In its effect on the value of colliery property, this state of things was very remarkable, and of this a picture is afforded by the following table :—

TABLE SHOWING THE FLUCTUATIONS IN COLLIERY SHARES DURING 1872.

Coal Shares.		May.	December.
		Thalers.	Thalers.
A. Mines of 1,000 shares—			
Baaker Mulde . .	1 share	2,200	2,500
Bismark . . .	,,	1,400	1,650
Carolinenglück . .	,,	790	1,200
Centrum . . .	,,	1,800	2,800
Constantin der Grosse .	,,	1,675	2,500
Dahlhausen Tiefbau .	,,	450	1,200
Deimelsberg . .	,,	1,300	2,200
Deutscher Kaiser . .	,,	560	—
Dorstfeld . . .	,,	2,000	2,000
Ewald	,,	300	500
Friedrich der Grosse .	,,	900	1,200
Hagenbeck . . .	,,	—	2,500
Hasenwinkel . . .	,,	725	2,500
Humboldt . . .	,,	—	500
Helene und Amalie .	,,	1,650	1,600
Jacob	,,	350	400
König Ludwig . .	,,	425	535
König Wilhelm . .	,,	1,550	2,500
Königin Elisabeth . .	,,	2,100	2,700
Langenbrahm . .	,,	1,000	1,600
Lothringen . . .	,,	260	425
Minster Stein . .	,,	450	750
Mont Cenis . . .	,,	280	—
Roland	,,	1,500	2,000
Scharnhorst . . .	,,	430	630
Unser Fritz . . .	,,	540	600
Victor	,,	650	800
Wasserschneppe . .	,,	300	300
Wolfsbank . . .	,,	2,000	3,000
B. In 10,000 shares—			
Tremonia . . .	,,	190	190
C. In 128 shares—			
Carolus Magnus . .	,,	9,000	11,000
Hoffnung . . .	,,	—	11,500
Consolidation . .	,,	—	28,000
Franciska Tiefbau .	,,	—	13,000
Neu Glück und Gewalt .	,,	5,000	5,000
Neu Iserlohn . .	,,	—	3,000
Portingriepen . .	,,	700	1,500
Rosenblumendellen .	,,	8,500	8,500
Sälzer und Nerrack .	,,	26,000	36,000
Silberbeck . . .	,,	5,000	5,000

The prosperity of the coal trade has had great effect on railways. In 1866 the Cöln-Minden carried 3,900,000, the Bergisch-Märkisch 3,135,855, the Rheinisch 689,749 tons. In 1871 Cöln-Minden carried 3,850,000, the Rheinisch 5,950,000 tons ; the Bergisch-Märkisch carrying 4,500,000 tons in 1870.

The iron trade was less prosperous than the coal trade in

[1] Imperial Quarter = 5¼ Scheffel.

[2] The transit of coal by the Dutch-Rhenish line also fell from 280,236 to 227,417 tons ; between 1870 and 1871 the same contraction of exports being apparent in the direction of Berlin and Frankfort.

1872, because the ironmasters were too seriously affected by the break-down of railway transport to be able to work up to their natural power. In other respects they had a most favourable year; and this is such a rare occurrence in the history of this branch of German commerce that it deserves particular mention. None but men on the spot know what struggles the ironmasters of the Rhine have gone through, nor how frequently the capital originally invested in large undertakings was lost. From the beginning there has been an effort to produce iron profitably at prices proportioned to those ruling in England and Belgium; and this amidst the vicissitudes of a protectionist legislation which at one time almost prevented importation. Even now that the trade expands under a more liberal tariff, prices are regulated by those of South Wales, Staffordshire, and Glasgow. With what success the ironmasters of the Rhine were enabled to increase and to cheapen production is apparent in this, that from 1857 to 1868 the quantity produced was trebled, and its value diminished by two-fifths to a-half. Since 1868 it was only from inability to supply the home demand with the means at their command that the Germans were constrained to import more foreign iron. Their produce has steadily risen in price, and so much of it is absorbed at home that the question of exportation abroad hardly admits of consideration. Yet there is no doubt, as I have stated elsewhere, that when railways are more numerous and traffic better regulated, when rates of transport are cheaper, and canals have multiplied the present scanty means of carriage, the Germans may not only satisfy their own wants, but compete with foreign countries on neutral markets. It is probable that years may elapse before this occurs; in the meanwhile imports will continue to increase, and the Rhenish provinces will take their share of English iron in the raw and manufactured state.

I have as yet no returns of the quantity of iron and iron manufactures produced in these districts in 1872, but there are copious statistics to prove the progress of the trade in earlier years, and the rapid advances made are amply illustrated by the statement that the amount of pig and other iron made in these provinces was 593,237 tons in 1860, and 1,816,756 tons in 1871; nor is it uninteresting to examine the details which I am enabled to furnish in the following table:—

TABLE SHOWING THE QUANTITIES OF IRON MADE UP IN THE MINING DISTRICTS OF BONN AND DORTMUND.

Sorts.	Years		
	1860.	1864.	1871.
	Tons.	Tons.	Tons.
Pig-iron	270,000	500,000	722,000
Pig steel-iron	4,359	36,735	141,589
Castings	58,630	84,926	133,764
Bar and rolled iron	192,031	283,893	491,204
Iron-plate	33,312	59,007	85,739
Wire	17,500	26,694	48,200
Steel	18,415	61,553	174,063
Total	593,237	—	1,816,756

The prices as they fluctuated since 1857 are as follows:—

PRICES OF IRON AND IRON MANUFACTURES PER TON FROM 1857 TO THE CLOSE OF 1872 IN THE RHENISH PROVINCES.

Sorts.	1857–8.	1867–8.	1871. Opening.	1871. Close	1872. Opening.	1872. Close.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Spiegel iron, best	5 11 0	3 12 0	5 14 0	7 10 0	12 8 0	12 0 0
,, ,, second	—	—	4 18 0	6 6 0	7 16 0	10 8 0
Bessemer	—	—	4 16 0	6 6 0	8 10 0	—
White	—	—	4 8 0	5 12 0	5 14 0	9 18 0
Grey and mottled	—	—	4 8 0	5 12 0	6 18 0	10 4 0
Iron plate	23 0 0	10 16 0	12 12 0	15 0 0	15 12 0	24 0 0
Bar, hammered	14 8 0	8 2 0	10 16 0	12 0 0	13 16 0	19 12 0
,, rolled	14 8 0	8 2 0	10 4 0	11 14 0	13 8 0	18 12 0
Wire	15 0 0[1]	10 16 0	9 0 0	11 2 0	13 10 0	16 10 0

Co-extensive with the rise of price in iron since 1868 wages have been advanced, and, taking Duisburg as a point for comparison, I find the following result:—

[1] These high prices were solely due to limited production under a system of protection.

WAGES OF MEN IN IRON WORKS AT PIECE WORK AND BY TIME.

	1868.	1872.
	s. d.	s. d.
First smelters (piece work) . per day	3 0	3 6
Second smelters (piece work) ,,	2 8	3 0
Smiths and fitters (piece work) ,,	2 5	2 11
Enginemen (daily wages) ,,	2 5	2 8
Firemen (daily wages) ,,	2 3	2 6 to 2 11
Coke burners (daily wages) ,,	2 6	3 6
Labourers (daily wages) ,,	1 9½	2 6

The men of all classes earn their wages in twelve-hour shifts, from six in the morning till six at night, with half an hour for breakfast, an hour for dinner, and half an hour for evening coffee; but the men at the blast-furnaces take twenty-four hour shifts once in every week, in order to change night shifts into day shifts, and *vice versâ*. At these rates of wages men are to be had in most of the iron works of this country, and it is acknowledged "that the increase of iron production will necessarily be limited for a considerable time by the insufficiency as to numbers and skill of the present race of mechanics and labourers;" and it is curious to note that in the face of a demand unparalleled anywhere, and with wages as high as can be desired, thousands of able-bodied workmen take leave of this country annually and migrate, with or without permission, to America.[1]

I might add to the returns which have been given of prices and wages a minute account of the number of new undertakings launched in these districts since 1871; I might point for proofs of prosperity not only to high earnings and prices, but to high quotation of shares in new and old companies. Such a course might interest a specialist; it would take up more time and space than I have at command. It has been calculated that if the labour market could have furnished more men and the railways more coal, the production of iron in these provinces would have been larger by a third than it proved to be. That a trade of such importance should have been so shackled cannot but have been favourable to importers, and, looking at the Zollverein returns, I find this view confirmed. In 1871 the total import of pig-iron into Prussia was 338,995 tons, against 165,757 tons in 1870. The total imports of the same article into the Zollverein was 440,831 tons in 1871, and 292,076 tons in the first half of 1872, showing a remarkable and important increase. A similar advance is apparent in the import of manufactured iron of all kinds.

Intimately connected with the coal and iron trades, and, indeed, with manufactures generally, is the state of railway communication in the Rhenish Provinces and Westphalia. In touching on a question so vast and so difficult, I venture to claim indulgence for possible mistakes in consideration of the shortness of my stay in this part of Germany, but, subject to future correction, I may state thus much:—There is no part of Germany in which railways are more numerous than here; the wants and defects of the system on which they are administered and kept up are not to be underrated, as I have had occasion to show; but, such as they are, they perform admirable services, and the net of intersecting or parallel lines which they form is so intricate as to require in the working an amount of patience, perseverance, and attention seldom to be met with in any country. Many stations are served by two or three companies at a time, yet the traffic is so large as to baffle them all. For this reason numerous branches are in course of construction, and new main lines are projected, which promise at no distant date to relieve the pressure so severely felt at this moment. Of paramount importance are those undertakings which involve the bridging of the Rhine. Till now there have been railway-bridges over the stream at Strasburg, Mayence, Coblentz, Cologne, and Hamm, near Düsseldorf. In one or two years we shall have new ones at the following places, viz.:—At Wesel for the Boxtel-Wesel and Venlo-Hamburgh lines; at Ruhrort for Aachen-Crefeld-Oberhausen; at Rheinhausen-Duisburg for Neuss-Dortmund; at Düsseldorf for the Neuss-Mettmann-Elberfeld; at Nippes-Cologne for the Cologne-Elberfeld line of the Rhenish Company; at Deutz for the Elberfeld line of the Berg-Märkisch Company; at Oberlahnstein for the direct railway Berlin-Wetzlar-Trêves-Thionville-Metz. The Wesel and Rheinhausen bridges are in the hands of the

[1] The returns from the Rhine Province and Westphalia for 1871 show an emigration of 5,000 souls.

contractors and considerably advanced. Branches are in course of construction from Stolberg and Düren to Gladbach; from Ruhrort to Sterkrade and Gelsenkirchen, and on to Castrop and Dortmund, as a loop to the main Cöln-Minden line; from Hattingen to Herdeke and Hagen; from Arnsburg to Warburg,[1] Lennep to Wipperfürth, Deutz to Donrath, Siegburg, and Pründerath. Others are projected from Cologne to Gladbach direct; from Opladen to Lennep; from Barmen to Blankenstein, Blankenstein-Hagen-Altenförde, and Hagen-Lüdenscheidt; from Düsseldorf viâ Mettmann to Elberfeld, Hoerde, and Dortmund. Others again are to run from Enskirchen on the one hand to Bonn, and on the other to Linzig, and from Bendorf, below Ehrenbreitstein, to Limburg. Millions have been raised by the Government and great companies for the construction of these lines, and for the equally important purpose of enlarging stations and doubling single lines. The Government has not as yet seen its way to alter the system of level crossings and head stations at present in existence, but it appears determined to prohibit them for the future.

Meanwhile a large work is contemplated, by which Dortmund shall be placed in communication with the Rhine below Ruhrort by means of a ship canal to be fed by the waters of the Emscher. The canal is to be broad enough and deep enough to float seagoing ships from the Rhine up to Dortmund, and the levels are described as being highly favourable to the undertaking and to involve the construction of very few locks. The Government appears willing to give energetic support to the canal, the extension of which to the neighbourhood of Minden would open a communication of great national interest between the Weser and the Rhine.

In some years we may expect to see the Emscher valley covered with collieries and iron works, and it will be no small matter that the produce should find its way cheaply not only to the Rhine, but up country to Bremen and Bremerhafen. At the present time there is a demand at Bremen only for good Rhenish screened coal for the use of the steamers of the Transatlantic Company: cheaper rates of carriage would take then the commoner sort of coal for household use.

Düsseldorf is advantageously placed as a centre from which to observe the condition of industry and commerce in the Rhenish provinces and Westphalia. Situated on the right bank of the Rhine, yet in connection with the towns of the left bank by direct railway communication, it is equally distant on the one hand from Crefeld and Gladbach as from Ruhrort and Essen or Elberfeld and Barmen. On a larger radius to the southward and westward, Aix-la-Chapelle, the seat of the cloth trade, is not farther away than Dortmund to the eastward, or Iserlohn or Hagen, where the great and small hardware factories flourish. It is not much further, again, from Düsseldorf to the iron mines of the Siegen district than to the collieries and furnaces or rolling-mills of the Ruhr and Emscher valleys. Due south, and comparatively close, lies Cologne, the general dépôt for "produce," and the banking-place for the Rhine country.

Düsseldorf is the chief port through which manufactured and half-manufactured goods of foreign origin are introduced into the Rhine provinces and Westphalia, and it still remains the chief port in spite of the establishment of a branch custom-house and bonded warehouse at Elberfeld and Barmen. It may, therefore, be convenient to group together the imports of both Elberfeld and Düsseldorf, returns of the latter being given for 1866, 1870, and 1871; of the former for 1870 and 1871 only.[2]

RETURN OF THE MOST IMPORTANT ARTICLES OF COMMERCE WHICH PAID DUTY AT ELBERFELD AND BARMEN IN 1870 AND 1871.

Articles.	1870.	1871.
	Centners.	Centners.
Cotton yarn, single and double (chiefly British)	22,554	35,351
Cotton yarn, treble, dyed and bleached	133	946
Raw silk	167	773
Woollen yarn	1,549	2,508
Woollen wares, unmilled, plain	1,731	2,258
Iron, wrought, in bars, &c.	—	9,857
„ plate	302	1,549
„ wheelbands and fashioned iron	1	332
„ cast and wrought-iron wares	254	234
Machinery, mostly of wood	415	55
„ „ cast-iron	355	1,333
„ „ wrought-iron or steel	296	44
Coffee	1,276	2,560
Rice	3,651	9,906
Soda	207	1,555
Oils (vegetable, not palm)	5,813	11,742
Train oil	703	426

[1] This railway has been opened since these lines were written.

[2] The custom-houses profess their inability to communicate statistics of imports for 1872 at so early a period of 1873 as the month of January.

RETURN OF THE MOST IMPORANT ARTICLES WHICH PAID DUTY AT THE CUSTOM-HOUSE OF DÜSSELDORF IN 1866, 1870, AND 1871.

Articles.	1866.	1870.	1871.
	Centners.	Centners.	Centners.
Cotton (raw)	8,582	8,115	8,806
Cotton yarn, single, double (chiefly British)	44,834	40,157	59,348
Cotton yarn, treble, &c.	269	1,960	636
Woollen yarn, single, double (chiefly British)	42,522	47,327	63,149
Woollen yarn, treble and double dyed	—	804	3,265
Woollens, unmilled, plain	181	655	1,441
Linen yarn	3,621	1,342	1,516
„ grey sacking	837	1,270	1,604
Iron, pig	34,220	64,832	80,058
„ wrought, in bars	—	1,865	6,316
„ wire	—	4,706	7,417
„ plate	—	9,181	18,008
„ tin-plate	—	95	233
„ wares	—	7,164	3,823
Ores and earths	—	68,326	77,796
Machinery, mostly of cast-iron	2,016	3,141	8,146
Coffee	—	47,339	41,633
Rice	—	42,732	37,580
Soda	3,406	3,793	5,069
Olive and rosemary (mixed) oil	33,287	22,337	43,337
Linseed oil	20,694	15,569	26,458
Train oil	—	3,739	3,897
Resin	—	3,226	6,958

I am tempted to compare the nature and increase of these imports with those of Cologne.

IMPORTS OF GOODS THAT PAID DUTY AT THE COLOGNE CUSTOM-HOUSE.

Articles.	1870.	1871.
	Centners.	Centners.
Cotton, raw	3,752	22,408
„ yarn	1,569	2,349
„ manufactures	888	1,497
Wool	4,542	15,978
„ yarn	7,444	13,788
„ wares	5,428	4,561
Coffee	—	166,584
Sugar, raw	—	21,736
Beetroot sugar (from Austria)	24,183	40,386
Wine	—	73,308

IMPORTS BY WAY OF THE RHINE UP STREAM INTO THE PORT OF COLOGNE.

Articles.	1870.	1871.
	Centners.	Centners.
Cotton, raw	20,538	22,748
„ yarn	3,329	6,734
„ goods	3,971	6,666
Woollen yarn	830	897
„ wares	1,362	2,187
Linen and sailcloth	5,217	5,439
Iron, pig	114,180	135,054
„ wares	5,501	9,231
Machinery	9,031	18,479
Coffee	105,050	141,712
Rice	42,444	34,777
Soda	5,881	7,472
Saltpetre	33,976	42,793
Potash	4,194	5,122
Linseed oil	60,955	76,589
Palm nuts	46,516	43,706
Palm and cocoanut oil	15,200	31,304
Train oil	18,895	27,224
Sugar, raw	5,177	2,962
Rye	268,476	434,573
Wheat	101,733	104,507
Dyes	6,133	3,780
Dye-woods	7,831	11,109
Petroleum	12,412	31,897
Guano	43,219	71,969

The Cologne returns alone show that the trade of that port is essentially a trade in produce as distinguished from that in manufactured and half-manufactured articles which we find at Düsseldorf and Elberfeld. There are indeed manufactures at Cologne; amongst others, a large spinnery and weaving establishment, which made up nearly 2,000,000 lbs. of yarns and 500,000 pieces of fustians and velveteens in 1871. There are iron works too, which turned out 250,000 centners of large, hard, and iron wares in 1871; but the trading community consists chiefly of bankers and produce merchants, and by far the largest proportion of the business is not manufacturing. According to public and private accounts the year which has just expired was highly favourable to the place, "the reports from factories, industrial establishments, and banks, describing business as prosperous and highly profitable."

One peculiar feature deserves passing notice. It is the gradual substitution of carriage by railway to carriage by water at Cologne. Thus the movement of the port of Cologne was 6,500,000 centners in 1858, and under 5,000,000 in 1871. But the outfall at Cologne is counterbalanced at Mannheim, where the movement of the port was 5,000,000 centners in 1858, and 8,000,000 in 1871; giving us a clue to the large business done with the South German States and Switzerland not only by the traders of the Lower Rhine country, but by foreign nations.

At Düsseldorf the quantity of goods shipped in 1871 amounted to 3,500,000 centners, of which more than 2,000,000 went down stream. In 1872, as I am informed, there was an improvement upon the trade of 1871 in every branch, both Düsseldorf and Elberfeld; and a notable increase is reported to me in the imports of cotton and woollen yarns and iron manufactures of every sort. Looking back to the statistics of the imports and exports of the Rhine country, as shown by the returns of the frontier port of Lobith on the Rhine, I note the following items as more particularly of interest :—

Articles.	1867.	1871.
IMPORTS.	Centners.	Centners.
Cotton, raw	189,918	316,700
„ yarn	75,104	125,708
„ goods	1,086	10,167
Soda and soda ashes	31,686	60,161
Iron, pig	1,073,947	3,500,285
„ wares	28,548	147,126
Olive oil	—	40,582
Linseed oil	197,614	136,754
Palm and other oils	65,456	258,451
Train oil	3,370	69,032
Sulphur	169,698	107,647
Coffee	527,355	598,416
Pepper	14,610	25,291
Herrings	—	21,227
Rice	153,081	169,136
Tea	446	2,257
Sugar, raw	104,257	5,465
„ refined	2,236	12,385
Linen yarn	1,790	11,914
Linen and sail cloth	9,409	30,422
Copper	10,914	47,079
Tin	6,622	16,333
Silk, raw and twisted	5,200	4,735
Wool	4,525	56,523
Woollen yarn	32,837	61,033
Woollens and half woollens	—	18,473
Dye-woods	114,325	128,304
EXPORTS.		
Wool	782	52,305
Woollen yarn	15,157	2,617
Woollens		27,135
Cotton yarn	12,493	10,045
„ goods	20,503	19,276
Hardwares	23,825	27,557
Pig-iron	214,701	607,885
Rails	292,514	230,553
Coarse cast-iron wares	323,441	57,108
Other iron wares and wares of steel		98,557
Wheat	439,208	66,039
Barley	478,647	12,195
Flour	271,605	125,430
Potato flour	38,229	
Potatoes	222,499	2,373
Sugar, raw	10,765	—
„ refined	273	3,801
Syrup	47,081	40,731
Wine	350,021	245,189
Beer	15,349	6,036
Mineral water	70,451	75,947
Tobacco, raw	13,267	25,541
„ manufactured	55,773	21,131
Sulphur ore	635,965	—
Lead	165,340	141,150
Zinc	268,924	99,069
Timber	1,788,308	238,002

The returns of imports speak for themselves: they confirm the impression that since the date of the Commercial Treaty with England, our trade with the Zollverein has made a rapid advance. The returns of the exports but partially display, if in some cases they display at all, the progress of German industry and manufactures. Some additional light may be thrown upon the difficult subject by the registers of the United States Consulate at Barmen-Elberfeld, which give us the following comparative results :—

EXPORTS FROM BARMEN-ELBERFELD TO THE UNITED STATES

As per certified invoices at the American Consulate, reduced to sterling :—

	1870.	1871.
	£	£
Cotton, manufactured, trimmings, tapes, yarns	92,832	108,460
Mixed woollens (wool and cotton)	104,800	110,891
Cotton and half-silk ribbands	71,827	100,984
Silks and half-silks	54,078	60,212
Velvet stuffs and ribbands	53,911	68,374
Buttons and button stuffs	28,042	37,409
Woollen cloths	150,227	172,128
Steel, iron, and brass wares	91,377	130,608
„ fine	3,795	5,902
Dyes and chemicals	21,146	26,125
Total	672,035	821,093

The trade of Elberfeld-Barmen with the United States is but a fraction of that which is carried on with other foreign states and Germany. It is progressing and prosperous; and, as I have reason to know, was very active in almost every quarter of the year which has just expired. What escapes our attention is the transit of the goods to foreign parts or places in Germany by rail. It may be said, and will probably appear, that the silk weavers and merchants laboured at the close of 1872 under a certain measure of depression. The quantities of silk tested for moisture at the testing-house of Elberfeld was 154,070 kilos. from the 1st of January to the 30th of November of last year, and in the same period of 1871, the quantity tested was 157,514 lbs., but this is a slight diminution in a manufacture of such importance and dealing with a raw material so expensive as silk.

At Crefeld, which is the seat of the Rhenish silk manufacture, and in this respect the rival of Elberfeld, there was also a decrease in the quantity of silk sent to the test-house in 1872, the amount tested being 388,153 kilos. in the first eleven months of the year, as against 399,885 kilos. in the corresponding period of 1871. Yet according to all the reports that came from Crefeld up to the close of October, the silk and velvet weavers of the town and its neighbourhood were remarkably active, it was difficult even at higher rates of wages to find labour; orders were especially large for the French market, and the demand for mixed cotton and silk stuffs and velvets was heavier than usual. It may be that difficulties which arose at the French custom-houses as to the duties on pieces delicately balanced in the quantities of cotton and silk introduced into them, occasioned a falling off in manufactures. The French tariff charges a lower duty for "dominant" cotton than for "dominant" silk, but the custom-houses frequently held that silk predominated where the manufacturer declared that the silk was of less weight than the cotton. It may be again that a large use of cotton in mixed stuffs caused the weavers to require less silk than they would otherwise have done. On these points I may be able to throw some light hereafter.

The following table gives a practical picture of the working of a large manufacture such as it is hardly possible to obtain elsewhere.

STATISTICS OF THE CREFELD VELVET AND SILK MANUFACTURE.

	1871.	1870.	1867.
	Number.	Number.	Number.
Average number of looms, viz.—			
For velvet	17,107	14,774	11,551
For velvet ribband	2,575	2,472	2,111
For silk stuffs	12,016	10,613	6,498
For silk ribband	378	354	289
	Thalers.	Thalers.	Thalers.
Business with—			
Germany	9,854,820	7,590,688	6,217,696
England	8,677,035	7,434,267	5,054,837
France	686,445	872,871	614,324
Other European countries	1,945,920	1,458,381	1,005,840
Non-European countries	4,325,895	3,217,524	2,083,781
Total	25,490,115	20,573,731	14,976,478
	Kilos.	Kilos.	Kilos.
Raw material used, viz.—			
Raw silk	364,821	279,704	228,578
Shap	101,379	81,067	33,646
Cotton	509,429	393,930	192,895
	Thalers.	Thalers.	Thalers.
Wages paid, viz.—			
Weavers	5,180,612	3,671,290	2,545,740
Winders	510,894	368,815	244,696
Shearers	165,497	123,837	94,650
Dyers	1,106,235	851,766	574,161
Priming	360,225	290,835	139,901

It is to be observed that a considerable number of looms are worked by cottagers in the vicinity of Crefeld, who vary the labours of the field with those of the weaver.

I close this portion of my report with some stray notices.

The Gladbach weaving and spinning factory gave a dividend of 14 per cent. in 1871, and will probably distribute as much for 1872.

The cloth-weavers of Eupen, near Verviers, and the weavers and spinners of Lennep, near Elberfeld, were out on strike during a great part of the spring of 1872, and resumed work, at Lennep, in April on the old scale, at Eupen on an improved scale of wages in June. The Bielefeld linen trade was very brisk throughout the year; weavers and spinners were actively employed, and towards the close of November it was difficult to find men enough for the work on hand. The scarcity of weavers was attributed to the attraction of higher pay in other branches of manufacture. The Ravensberg spinnery at Bielefeld declared a dividend of 6 per cent. for 1871. At Remschied, the Sheffield of the Rhine province, where upwards of 300,000 souls find their livelihood in making files, tools, and other sorts of hardware, the greatest activity prevailed throughout the year that has just expired. The workmen combined in December for an increase of wages, and this has led to a lock-out on the part of the masters, which, at the moment of writing this report still continues, to the great distress of more than 1,000 hands.

A chain towing company has been formed for the navigation of the Rhine, and there is every reason to believe that parts of the line will be opened in the spring of 1873. The chain has been laid within the last few days between Duisburg and Emmerich.

Nine pontoon bridges are being thrown across the Rhine, four of which are in the Baden country, and four in Alsace. At Schönau, Reinau, and Gerstheim, the works are not finished. At Hüningen the bridge was opened in September.

The Harvest.—At a very early period of the season it was considered probable that the German harvest would be a good one. On the Rhine especially the prospect seemed peculiarly flattering. Winter and spring sown corn gave equal promise of plenty; potatoes were planted and grew under favourable circumstances, and clover rose in capital condition. Beyond Germany on every side the reports of agriculturists were less hopeful, though not of a nature to create serious alarm. Drought which threatened Hungary gave way in June to moist and mild weather; cold and damp which kept back the plants in England and France seemed to be counteracted in June by warmth and sun. It was held at the international market of Leipzig that quotations would remain moderate with a downward tendency, and speculators contracted readily to deliver at Cologne in November, wheat at £1 0*s.* 7*d.* per 200 lbs., and rye at 16*s.*, but the hopes of the trade were not realized. The forecast of the harvest throughout Europe proved to be incorrect, and the crops were cast as middling in corn and plentiful in straw, on the Rhine, but below the average in North and Central Germany, France, England, and Hungary. In the district of Düsseldorf the sheaves were so heavy and so numerous that they could not be garnered in the ordinary way. In some places both wheat and rye returned as much as 1,400 lbs. of grain and 2,500 lbs. of straw per morgen (= ½ an acre). Barley was equally good; oats were nearly so, and potatoes were plentiful and healthy; whilst clover and hay abounded. But such good results as these were not realized in other parts of Germany, and it was soon apparent that the harvest as a whole was under middling. Wheat was reported at 92, rye at 81, barley at 93, and oats at 99 per cent. of middling. Oil seed, especially rape seed, was produced in greater plenty than for many years past, and the returns show a yield of 10 to 20 per cent. above the average; flax gave 94, hops 73 per cent. of a middling crop. Tobacco in all parts of the country was plentiful and excellent, and prices at Mannheim in October ranged between 18 and 21 fl. (£1 13*s.* 6*d.* to £1 16*s.* 9*d.*) per 50 lb. Prices in May at Mayence were £4 7*s.* 6*d.* for ribbed and pressed tobaccos, £2 12*s.* 6*d.* for wrapperleaf per 50 lb. Quotations of corn ranged much higher at Cologne in November than speculators anticipated, as the following table will show:—

Sorts.	Quarter ended March 31.		Quarter ended June 30.		Quarter ended September 30.		Quarter ended December 31.	
	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.	Lowest.	Highest.
	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*
Wheat per 200 lbs.	1 4 4	1 6 0	1 2 9	1 7 3	1 3 3	1 7 9	1 3 0	1 6 6
Rye per 200 lbs.	0 16 9	0 17 6	0 16 6	0 17 9	0 14 10½	0 18 9	0 15 3½	0 18 0
Barley per 200 lbs.	0 14 4	0 14 4	0 14 1	0 14 7	0 15 6	0 16 0	0 15 6	0 17 0
Oats per 200 lbs.	0 12 5	0 12 5	0 12 4	0 12 8	0 13 7	0 13 7	0 13 0	0 14 7½
Potatoes per 200 lbs.	0 8 0	0 8 0	0 8 0	0 8 0	0 4 10	0 4 10	0 5 0	0 5 0

The following table shows further the price of wheat and rye at Cologne at the close of each year since 1863:—

Year.	Wheat per 200 lbs.	Rye, per 200 lbs.
	£ *s.* *d.*	£ *s.* *d.*
1863	0 17 3	0 13 0
1864	0 16 0	0 12 6
1865	0 19 0	0 14 6
1866	1 7 0	0 18 0
1867	1 8 6	1 4 0
1868	1 0 6	0 17 6
1869	0 19 0	0 16 0
1870	1 5 6	0 19 6
1871	1 6 3	1 0 6
1872	1 6 6	0 18 0

Wine.—The vintage of 1872 is the poorest of this century. This melancholy result is due to the heavy frosts of the autumn of 1870 which killed most of the fruit-bearing wood. Caub, Lorch, Assmannshausen, Rüdesheim, Berg, Schloss Johannisberg, and Winkeler Dachberg suffered less than other places, and yielded wine to the amount of one sixth of an average crop; but there are spots at Hochheim where patches of seven acres scarcely gave 380 bottles, and others in the Rhinegau where fields of four and five acres returned little more than 190 bottles (1 ohm). Prices of commonest sorts in the Rhinegau and Palatinate averaged £6 per ohm of 180 bottles at the close of October.

Money.—Money was plentiful throughout the year, and speculation showed considerable activity. So much eagerness was shown in floating new enterprises, and so much money was engaged that the Bank of Berlin refused at last to discount what is called "Gründerspapier" (accommodation bills). A panic, accompanied by a heavy fall in securities, occurred in December in consequence. Since then there has been a rally, but it is still supposed in some quarters that Germany is too deeply engaged in speculation to be beyond the danger, even now, of a disastrous crisis. Bank discount was 7 per cent. at Berlin during three weeks of November, it fell to 6 and to 5 per cent. on the 1st and 12th of December.

The following table shows the state of the exchanges at Cologne during the year:—

1871.	At Ten Days.		At Three Months.	
	Th. Sgr.	Th. Sgr.	Th. Sgr.	Th. Sgr.
April . .	6 22¾ to	6 23¾	6 21 to	6 21⅜
May . .	6 23⅜ „	6 24⅝	6 21¼ „	6 22
June . .	6 24 „	6 24⅝	6 21¾ „	6 21⅞
July . .	6 23 „	6 23¾	6 21¾ „	6 21⅞
August .	6 23 „	6 23½	6 20¾ „	6 21¼
September.	6 22⅞ „	6 23	6 20¾ „	6 21
October .	6 22¾ „	6 23	6 20⅛ „	6 20½
November.	6 23⅞ „	6 24⅞	6 20⅜ „	6 21¼
December.	6 22⅞ „	6 23½	6 20¼ „	6 21

Düsseldorf, January 31, 1873.

Rhenish Provinces.

Further Report by Consul Crowe on the Trade and Commerce of the Rhenish Provinces for the Year 1872.

It has been stated, on the authority of merchants and others, that the general trade and manufacture of the Rhenish Provinces improved in 1872. Official returns now fully confirm these statements.

The following table supplies a correct account of the quantities of goods which paid duty or otherwise passed into the open channels of trade at Düsseldorf in 1872, not including the goods introduced in bond or forwarded under seal to inland custom-houses:—

	Centners.
Cotton	15,357
„ yarn, single and double	67,614
„ ditto, bleached, dyed, and treble, raw, bleached, or dyed	2,636
Cotton manufactures of all kinds	672
Raw iron and scrap	178,288
Wrought iron, bars and lumps	2,343
T iron	1,104
Raw steel	13,436
Iron and steel wire	10,370
„ wrought as parts of machinery	15,816
Lump iron and raw steel blocks	1,290
Iron plate, black	12,855
„ white	2,345
Coarse iron castings	3,852
„ wares of wrought iron.	8,199
„ „ rolled	2,229
Fine iron wares	289
Portland cement	75,652
Machinery, mostly cast iron	15,420
Linen yarn	1,183
Woollen yarn, single	54,339
„ treble, double, and dyed	2,217
Woollens, unmilled and plain	1,272
„ milled and plain	696
Currants and raisins	35,531
Coffee	11,057
Rice	26,997
Tobacco leaves	5,839
Olive and rosemary oils, mixed	23,691
Linseed oil	10,049
Other oils	16,781
Train oils	3,716
Resin	9,258
Petroleum	1,882
Other mineral oils	18,916
Raw soda	3,163
Indigo	1,778
Dyewoods, red, blue, yellow	5,305

The following table, showing the descriptions and value of merchandise exported to the United States from the districts of Elberfeld and Barmen in 1872, gives us the means of comparing this year with previous ones, and displays a considerable increase:—

	£
Cotton goods, braids, trimmings, &c.	103,844
Cotton and half silk ribbands and hatbands	186,552
Woollens and half woollens	155,020
Dress and piece goods of silk and half silk	39,431
Linen goods	5,257
Velvet and velvet ribbands	74,261
Buttons and buttonry	30,335
Woollen cloth	152,981
Steel, iron and brass ware, hardware, and cutlery	132,709
Plated ware, glass, and earthenware	3,370
Dyes and chemicals	28,951
Wine	273
Miscellaneous	5,874
Gloves	938
Total	919,796

The exports of 1872 are larger by nearly £100,000 than those of 1871. They were made to the extent of two-thirds through the port of Bremen; and this is a fact which partially explains the prosperity of the steam-packet line which has been recently established between that port and the ports of the United States.

The imports of goods into Cologne up stream have been given for 1871. I am now able to add some of the imports for 1872, which are as follows:—

	Centners.
Cotton, raw	33,517
„ yarn	8,789
„ goods	7,526
Woollen yarn	—
„ wares	—
Linen and sail cloth	—
Iron, pig	184,721
„ wares	14,412
Machinery	12,862
Coffee	155,371
Rice	33,011
Soda	4,544
Saltpetre	32,405
Potash	—
Linseed oil	57,713
Palm nuts	79,888
„ oil	34,052
Train oil	28,451
Sugar, raw	7,364
Rye	356,703
Wheat	3,615
Dyes	4,845
Dye woods	8,207
Petroleum	16,774
Guano	48,677

The imports into Cologne up stream in 1872 were 2,178,933 centners as compared with 2,140,690 in 1871. The imports down stream were 2,012,161 centners in 1872, and 1,707,119 in 1871.

From official sources I learn the movement of the coal trade of the Saar district in 1872 as follows:—The quantity of coals shipped on the Saar Canal was 539,548 tons; more than half of which was exported into Alsace and Lorraine. The quantity shipped on the Saar and Moselle was 39,699 tons, most of which was for consumption in Prussia.

The royalty on coals (2 per cent. of the net earnings of collieries) gave a surplus to the treasury in 1872 of 8,000,000 th. (over £1,000,000 sterling).

The quantity of tobacco produced in the Zollverein in one year, from July, 1871, to June 30, 1872, was 717,907 centners; the quantity of tobacco imported in the same period being 986,381 centners.

Düsseldorf, April 3, 1873.

THE MANUFACTURE OF FURNITURE IN SOLID WOOD,

AT THE WORKS OF MM. MAZAROZ, RIBAILLIER, AND CO.[1]

SINCE the grand mediæval movement, of which Victor Hugo's "Notre-Dame de Paris" was the most brilliant expression, the taste for ancient objects has gradually developed with an intensity almost incredible. The stuffs, the china-ware, and above all the furniture of preceding centuries, are, now that they are old and battered, always sold for prices far higher than they could have cost at the time of their fabrication. In this tendency it would be wrong to see nothing but a simple fashion, a mania and an exaggeration, based upon fantasy and imitation; all the men of taste of one nation, or, we might well say, of the two greatest nations in the world, France and England, could not possibly be deceived to this extent, and with this unanimity of their fantasy, had it not a solid and serious basis. And this fashion for antique furniture does rest upon a very reasonable and very logical foundation,—at first in its disdain for phantom furniture, which, through the perfecting of wood-working machines, has arrived at the last degrees of veneer, scarcely presenting the slightest degree of solidity, the mahogany and rose-wood with which they are coated cracking at the slightest shock, and peeling off at the least change in the dampness or dryness of the weather. All the world, too, knows equally well that the dismal furniture of thirty years ago is equally inelegant in appearance, and uncomfortable in use. There is, then, in the desire of purchasing antique furniture, the just idea of procuring articles altogether solidly built, the form of which is always, if not absolutely conformable to the rules of art, at least entirely different from the mahogany-veneer articles which, from their nature, can only be subject to a very limited number of combinations, and can never furnish to the taste of architects and designers the same resources as solid wood. A longing to escape from the cold and monotonous furniture of the preceding generation, added to the *renaissance* movement of the year 1830, caused a greedy demand for antique furniture to suddenly arise; but when all of those articles which had remained sound and solid were sold off, it was necessary to repair, restore, and strengthen those articles which were only discovered in fragments. The house to which this chapter is consecrated, commenced business life by undertaking these repairs, and its foundation dates from the year 1834.

M. Ribaillier was among the most skilful of the "restorers" of those coffers and cabinets which were the rage at the commencement of the reign of Louis-Philippe. The *romantiques*, his disciples, became more and more numerous, and the price of furniture recognized and warranted as antique more and more elevated; each man of them must needs have something, were it only a stool with twisted legs. The trade met this taste, at first, by imitating the furniture of the middle ages as well as possible, piercing worm-holes to give it a more probable air, and treating it with wire brushes, so as to perfectly simulate the attacks of time; then they renounced these innocent deceits, and declared openly that they made furniture in solid wood, turned and carved to imitate antique furniture, and sold the articles without pretending that they were anything else than objects altogether new.

Little by little a group of artists and skilful workmen was formed, and a great and profitable trade, which we think will never again be destroyed, was revived to enjoy a greater importance than it has ever had.

At the commencement there were grave errors in taste, which much compromised the success of this happy attempt. Thus the middle age reigned at first exclusively, and invaded all the articles of every room, without any regard to their destination or their size. To-day a reasonable eclecticism has known how to assign to each epoch a different place. Thus the antichamber or hall, the dining-room, the smoking-room, and the library, when they are of a certain proportion and size, perfectly accept the style of the *moyen âge* and that of Louis XIII.

The *salon* or drawing-room may be fitted with furniture of the period of Louis XIV., of white wood, black wood, and, especially, gilt wood, with rich stuffs; the bed-room should in most cases contain the carved and finely gilt wood-work of the close of Louis XIII. or commencement of Louis XV.; and the boudoir in Louis XVI., when it is not Chinese, Persian, or purely fantastic. It is evident that these arrangements should vary according to the size of the chambers to be furnished, and to the means and position of those who are going to inhabit them. Amidst these different styles we are unable to define what is termed the *style Napoléon III.*, for here the freest possible eclecticism governs the construction of the furniture, as it governs our contemporary architecture and dress.

Since the year 1850, the period when M. Mazaroz, the son-in-law and partner of M. Ribaillier, founded the large workshops in the rue Ternaux (Popincourt), constant researches have accumulated, in this establishment, models of every age and every country, and the designs and books published formerly, which contain such precious indications for us now. Contemporary artists, inspired, however, almost always by study of the antique, and directed by the most renowned architects, compose new models more completely in accord with the necessities of our dwellings; the international exhibitions, by stimulating the self-love of the workmen, have still further elevated the level of the art. By comparing one thing with another the public ended by discovering that, being of only the same cost, a piece of furniture in massive wood was preferable to its counterpart in veneer; orders poured in, and the firm of Mazaroz took the considerable development which it has to-day. Without being an eye-witness, one could in no way imagine the multiplicity of the operations to which a lump of wood is submitted before it is transformed into a piece of furniture. Cut down in the forests, sometimes roughly squared, often altogether unsplit, it is purchased far beyond the town boundary, and has to pay the *octroi* duty according to its bulk, whether it be still covered with its bark or split up. In special establishments they cut away all that cannot be utilized, and they divide it into planks, thicker or thinner, or into blocks more or less strong. It is then necessary to bring it to a determined state of dryness, which shall make it into a body not entirely dead—for then it would fall away rapidly in decomposition—but, so to speak, mummified, being no longer subject to the changes of form and density which affect wood freshly cut.

As a first step we may imagine that they place the plank or block in a stove-chamber, and by evaporating all the water it contains this result is rapidly attained. In some circumstances, and with certain precautions, they can for special purposes dry the wood in systematic stove-chambers, in the midst of an atmosphere of smoke produced from wood sawdust, when it retains a portion of its constituent elements.

But this altogether novel process should be applied only to those parts of the article of furniture exposed to the full air, and not to the pannelling at the sides; moreover, this process is very tedious, requiring the wood, according to its thickness, to sojourn from one to two months in the stove-room.

It is true that two months are nothing compared to the time of sojourn in the timber-yard imposed upon all woods intended for furniture. Thus, for the firm we are describing, a timber-yard, situate under the walls of the prison of the *Jeunes Détenus*, contains a considerable stock of a very high value, accumulated pile by pile during the last fifteen years, at an average price of three hundred francs the cubic metre. The manufacturers have the greatest interest in escaping from this accumulation of idle capital; thus they seek every possible means of drying the woods rapidly without evaporating them or decomposing their fibres. There is another reason which urges forward some new means of drying, and this is, that in a few years, if business augments as it promises, they will no longer be able to find woods dried in the open air at all, even if they were willing to pay an exorbitant price. In our century it is not everyone who has the courage to accumulate materials for work that will be executed in fifteen years' time.

Oak, walnut, pear, beech, elm, alder, maple, linden, willow, lie there in the open air in piles worth from eighteen thousand to twenty thousand francs, waiting for long years until their turn shall come. From time to time, after having prepared them with the saw, so as to free them from the portions damaged through contact with the air, they are carried into a great covered drying shed, open at the sides to a current of air, which takes away what of the sap there was left. There also are gathered together all the foreign woods, such as mahogany, rose-wood, violet wood, coming from Guiana, and a small quantity of ebony. It is from this drying shed that the woods are taken to rue Fernaux, where they are needed for manufacturing purposes.

There they are brought into a workshop situated on the ground floor, and fitted with the different cunningly perfected tools with which their transformation has to be effected.

This is the process in the construction of a piece of furniture. The buyer selects from the numberless designs of the firm the forms and ornamentation that he desires. Often, too, the architect who has built the house does not disdain himself to design the furniture that shall complete his work, finding in the different massive woods a material that will lend itself to all the dispositions of their different styles. Architects of the first renown have enabled M. Mazaroz to execute true works of art in all the styles.

[1] Translated from M. Turgan's "Les Grandes Usines."

WOOD-CARVING AT THE WORKS

MM. MAZAROZ, RIBAILLIER, AND CO.

In turning over the photographic album of the firm's models, or in looking at the manufactured furniture, we may see the purest Greek side by side with the boldest Gothic, fluted Doric facing the twisted column.

Given these different indications they make a first reduced plan, giving an idea of the whole, and pointing out the principal ornaments. If this sketch is adopted by the architect, they trace a definite plan on a large scale, which allows the workman to construct his piece of furniture precisely as if he were building a house. He begins by asking at the warehouse for the woods which he requires. The embosser (*débiteur*), with the aid of what they term *poncifs*, or pricked cardboard patterns, cut out according to the actual design, traces on the planks, blocks, or boards the lines that the saw has to follow; the "embosser" is careful to arrange all his lines so as to economize the wood as much as possible, and to fill in in little sections the portions that are not included in the great sections. The straight portions and the angles, more or less acute, are cut with extreme facility by the circular saw; here, however, the workman needs great coolness and address, for the slightest hesitation would change the direction of the piece pushed in front of the saw, and the least carelessness and inattention might cause him to cut his hands more or less seriously. The carved parts are put on the platform of the ribbon-saw, and are cut out according to the line indicated by the workman charged with this duty.

All the fragments, roughly shaped by these preliminary operations, are now carried to the joiner who is to construct the piece of furniture. He then gives the wood its true proportion, planes it, squares it, moulds it, and gathers together all the different parts which compose the different pieces, which by-and-by will constitute the article of furniture. He sees, then, by his plan, how to model each individual piece, and what design to follow—grooved or in relief, straight or twisted, mouldings simple or complicated, fettling broad or narrow, and finally, bas-reliefs and carvings in high-relief.

Of these different ornaments the most complicated are carved by the hand and by true artists; the simplest are at present made by ingenious mechanical processes, for it is now well recognized in industry that certain things are best done by machinery, whilst others are better executed by the hand of man. There would then be a want of sense in not demanding from all instruments newly created the means of working better, quicker, and at a cheaper cost. Thus most of the mouldings are chiselled with an instrument which they call the *toupie*, constructed by M. Perrin, the mechanician who gave his name to the ribbon-saw which to-day renders such essential services to a great number of very different industries.

This is how the *toupie* is constructed. From the midst of a cast-iron table, polished and perfectly plane, rises a pivot moved by a transmission which gives it a rotation of 2,400 turns a minute; this iron pivot is split so as to receive the blades of polished steel, the edge of which is the profile of the moulding they wish to obtain. The blades are placed within reach of the workman in a cupboard, from which he selects the profile of the form and size required; he fixes it to the pivot as solidly as possible, or the centrifugal force obtained by the rotation would shake out the blade, and project it with violence sufficiently great to grievously wound the workmen whom it struck, or, at the very least, to damage the piece at which they are working. The plank, the rod, or the frame, receives in an instant a moulding which would formerly have required the labour of many entire days, and with such a regularity and evenness that nothing more is necessary but a simple passage through glass-paper to finish it altogether. Beside this *toupie* stands the intermittent saw which executes the interior fettlings; this machine, which we notice in our description of the workshops of MM. Pleyel and of M. Alexandre, is here much newer and more elegant; it was constructed by M. Perrin, and receives motion from a little crank worked by the general transmission; the cylindrical or twisted pieces are turned by the chisel upon lathes worked by the motive power that animates all the machine-tools in the establishment.

When all the portions of an article of furniture have received their general and rudimentary form from the Perrin saw, from the *toupie*, from the intermittent saw, and from the various lathes, they are handed over to the head of the wood-carving establishment—and here the actual artistic work, the speciality of the firm, commences. More than 250 sculptors or carvers are employed by M. Mazaroz; but these are not all concentrated in the workshops of rue Ternaux; most of them remain at home, and work there either by themselves or surrounded with a few assistants; generally these men are old pupils of the firm's, who, having married, prefer an altogether domestic life, and in this choice they are encouraged by M. Mazaroz. They come themselves to get the pieces that have to be sculptured as well as the models, and when they have finished their task they carry back the whole. Still the workshop at the central establishment is very large, and contains all the different examples of workmanship. We give in our illustration some idea of its strange and interesting appearance. At one of the extremities they are executing large pieces. On the bench lies a block of American walnut wood, which a skilful sculptor is carving precisely as if it were a marble statue; behind him is the plaster model according to which he works; this fine piece is destined to be a portion of a mantelpiece ordered by the painter Gérôme. The planks which support the walls are covered with statuettes in plaster, and terra-cotta, and models of animals, flowers and ornaments; from the beams hang masks and bas-reliefs and boards covered with designs. Leaning against the partition that separates the carvers from the joiners, and huddled together side by side, stand the statues which have served as models for the firm's most celebrated compositions—the nymph holding the clock rests between the falconer and the fisherman, two charming figures ornamenting a sideboard, sold many times since the exhibition of 1855, and the first copy of which was purchased by Napoleon III.

Between the wall and the windows stretch two long tables, upon which two lines of carvers rest the wood at which they are working, and place the numerous tools they may require. An intelligent division of the labour according to special aptitude enables the artist to work quicker and better, and consequently to gain more, and gives the manufacturer the chance of selling at a cheaper rate. Thus one man is the best for executing the figure, another for animals, a third for garlands and flowers, a fourth for skill in smoothing and finishing; if, then, a piece require all these different labours, it passes through four several hands, receiving from each person a complement of its perfection. Sometimes the base itself ought to have the grained appearance of shagreen leather; they then use a special tool, a kind of punch, the surface of which is rough with little points, like the wafer seals they used long ago, when people still took the trouble to seal. By striking with a mallet upon this punch, to which is given a slow rotation, a granulation is produced which has a very good effect, especially in blackened woods. All carvings demand a much greater perfection and finish when they are made upon woods like oak or walnut, that will be left altogether visible, than when made upon woods that are going to be gilt or even painted white. Here there is an infinite variety of price, as in engraving on wood and chasing upon metal; but if there be a difference in the fineness of execution, there is, however, one point common to all the carvings coming from rue Ternaux: all are cut from the block; that is to say, they are carved from the panel, the mounting, or the cornice which supports them—never made in pieces and stuck together, as too often happens in cheap imitations. We will not expand upon the merits of a workshop the superiority of which has been confessed at every exhibition, but will follow these carved pieces, which are taken back to the joiners after having been polished successively with glass-papers of different grades.

The joiners, who have already among themselves finished all the parts that are not covered with ornaments, now collect all together; they use glue to fix the different parts, by an over-plus of precaution, because in perfect joinery there ought to be neither peg nor glue; all the parts ought to be so well executed that they would fit through their very forms. The same men are charged with fitting on the locks, &c., by the solidity of which we were much struck. The firm formerly manufactured its own locks, but was forced, by want of space, to have recourse to other makers, and now they are obtained at a cost of about 5,000 francs a month—a considerable figure for nothing but locks, hinges, screws, and castors.

The pieces of furniture, once put together, are taken down into a special workshop, where they receive certain preparations which give them a more agreeable appearance, and at the same time assures them a much longer duration by shielding the wood from contact with the air, and hindering insects from lodging in it. One only of these preparations is made in the joiners' shop and by the joiners themselves—this is the black wood polish with charcoal.

All the world now knows those articles of furniture of a beautiful dead black colour, with sharp clear cut edges, and a smooth surface, the wood of which seems to have the density of ebony; viewing them side by side with furniture rendered black by paint and varnish, the difference is so sensible that the considerable margin of price separating the two kinds explains itself without need of any commentary. The operations are much longer and much more minute in this mode of charcoal polishing, which respects every detail of the carving, while paint and varnish would clog up the holes and widen the ridges. In the first process they employ only carefully selected woods of a close and compact grain; they cover them with a coat of camphor dissolved in water, and almost immediately afterwards with another coat com-

posed chiefly of sulphate of iron and nut-gall. The two compositions in blending penetrate the wood and give it an indelible tinge, and at the same time render it impervious to the attacks of insects.

When these two coats are sufficiently dry, they rub the surface of the wood at first with a very hard brush of couch-grass (*chiendent*), and then with charcoal of substances as light and friable as possible, because if a single hard grain remained in the charcoal this alone would scratch the surface, which they wish, on the contrary, to render perfectly smooth. The flat parts are rubbed with natural stick charcoal, the indented portions and crevices with charcoal powder. At once, almost simultaneously, and alternatively with the charcoal, the workman also rubs his piece of furniture with flannel soaked in linseed oil and the essence of turpentine. These pouncings, repeated several times, cause the charcoal powder and the oil to penetrate into the wood, giving the article of furniture a beautiful colour and a perfect polish which has none of the flaws of ordinary varnish. Black-wood polished with charcoal is coming day by day to be in greater demand; it is most serviceable; it does not tarnish like gilding, nor grow yellow like white wood, and in furnishing a drawing-room it agrees very happily with gilt bronzes and rich stuffs. In the dining-room, too, it is thoroughly in its place to show off the plate to the greatest advantage, and in the library it supplies a capital framework for handsomely bound books.

The other woods receive a protecting coating which is the same for almost all of them; this is the common encaustic, more or less modified or tinted, the base of which is wax dissolved in turpentine. To give oak and walnut the rather deeper tone they would acquire by age, they cover them in the first instance with a solution of potash and soot boiled in water; when this solution is dried the encaustic is then applied. Certain woods, such as the walnut of Auvergne, which are exquisitely veined, and of a colour beautiful in itself, are treated only with the varnish indispensable to their preservation.

Wood painted white, the rage for which was so general under Louis XVI., and which at present would recover a great share of public favour if the painting were better and more variously executed by specialists devoted to the branch, has still obtained a certain success, especially during the last year or two.

To paint the wood white they begin by pouncing with pumice-stone, so as to take off the smallest asperities, then they cover it with coats of white lead, becoming whiter and whiter, and finishing by snow white or oxide of zinc, or white-lead from which all metallic traces have been removed; between each coat the pieces are left before the fire, at which gilded and black-lacquer from time to time are warmed. The thinner the coat and the longer the time of drying, the better is the appearance of the white paint. But in the present day orders are so pressing, and all things are so rapidly done, that three or four coats are held to be sufficient.

Very pretty effects are obtained by retracing the white ground with bands of colour-green, blue and mauve; sometimes also golds of different tones are happily mingled with these colours. Porcelain and china and enamel may be employed in the ornamentation of furniture, but without profusion, and with a careful sobriety, for an abuse of these means, far from augmenting the effect, would, on the contrary, diminish it, and probably lead into the extreme of bad taste. We regret that they no longer employ the beautiful decorations of the time of Louis XV. in colour ornaments upon a flat ground of dead gold.

As we said at the beginning of this study, the firm of Mazaroz, Riballier, and Co., commencing by carved oak furniture of the middle ages, have arrived by degrees at producing every style of furniture except the veneered; but if the firm at present confines itself to the use of solid woods, it has singularly extended its scope in general furniture. Thus in their workshop we see not only cabinets, tables, chairs, sideboards, and beds, but there are also panels, brackets, doors, cornices, and altars, and carved balustrades for churches; and to utilize still further the numerous models of the establishment, they have recently founded a workshop for casts, where cornices, rosaces, and mouldings for ceilings and walls are made. This branch of manufacture, at present so important, is very simple. They begin by making a mould of plastic earth, not a finished design, but presenting the positions and the projections of the ornaments; on this mould they make a first matrix, on which they model a plaster proof in relief. The carver chisels this proof, bringing it to the required degree of perfection, and this now is the true model on which they mould the actual matrix. When this model is finished, they mould on it either plaster, which is removed piece by piece to form the matrix, or hot-melted gelatine. In cooling, the latter takes the perfect shape, and, thanks to its elasticity, can be detached without being broken. In these matrices, whether of plaster or gelatine, they model, by kneading with the hand, a warm mixture of strong paste and Spanish white, placed in layers between sheets of a specially prepared paper. When the composition cools it is of an extreme solidity, especially if they are careful to introduce zinc wires, which, like a skeleton, fasten together the different parts of garlands and rosaces. The cast workshop of rue Ternaux is already in full activity, and its business is increasing every day. One thing being intimately connected with another, in the path which the architects have led M. Mazaroz into, he has now established an upholstery workshop, where, thanks to the assistance of the sewing-machine, they apply to the several stuffs selected by the architect presiding over the particular work, various ornamentations either in cloth or velvet, which bestow an air of thorough unity upon the furniture when completed.

At present the manufactory in the rue Ternaux occupies as many as six hundred workmen, the wages of whom have a high average, the joiners gaining from five to twelve francs per diem, the upholsterers from five to ten, the carvers from four to twenty. Evidently these wages are above those in other branches of skilled labour, and it is difficult to raise them without augmenting also the prices of furniture, and consequently running counter to the policy of a firm which has endeavoured, above all, to place solid furniture within the easy reach of the masses. But if they cannot elevate the price of the handiwork, could they not at least modify the condition of haste and precipitation under which the work is executed? The workman finds but little time and calm to perfect his work or to instruct himself in the principles of his art. It is not to the head of the house that we address this reproach, but to an indecisive and impatient public, which always delays its orders as long as possible, and then demands the delivery of its requirements upon terms it is impossible to fulfil. There has for some years been much talk upon art as applied to industry, and now that it is somewhat late, we all see that the position of our industries *de luxe* is in a sorry way—not financially, but artistically. As an endeavour to remedy this evil, a meeting of honourable and devoted men have founded a capitally-intentioned society, in which we have the honour of taking part. But as long as the buyer refuses to renounce his haste in possessing, quite logical in pure industry, and for large objects turned out by machinery, he will find that his haste is fatal wherever art has to intervene, and he will obtain insufficient results. So long as the workman shall not have time to instruct himself, and even to dream a little over his work, industrial art will gradually decline; *ars longa*, as the ancients said. If, then, they wish for objects really artistic, they must not only pay an equivalent of money value, but, above all, give time for their manufacture.

H. C.

ECONOMY AND TRADE.[1]

By Mr. Thomas Brassey, M. P.

IN the following address I shall devote myself to the task of reviewing, I hope in an impartial spirit, the most recent phases of the labour movement. The great advance of wages is a conspicuous feature of modern English industry, and is obviously due to the rapid growth of the general trade of the country. The long depression, following on the panic of 1866, has been succeeded by a period of unprecedented activity in every branch of our export trade. The demands upon the labour market have far exceeded the supply: and the artizan and labourer have not been slow to take advantage of a situation which afforded to them a brilliant opportunity. In the interval of four years—from 1866 to 1869, both years inclusive—the exports of the produce and manufactures of the United Kingdom had remained stationary. Subsequently the value has risen from £190,000,000 in 1869, to £256,257,000 in 1872. Such a leap was not possible without imposing a strain upon the powers of our labouring population which must inevitably have led to a material alteration in the rate of wages. It is too often alleged that the recent advance of wages is really attributable to a series of successful strikes. I maintain, on the contrary, that a strike against a falling market is never successful, and that trades unions, as an organization for the purpose of raising wages, can never do more than assist the workman to obtain an advance at a somewhat earlier date than that at which the competition among employers would have brought about the same result. I may quote the unfortunate strike in South Wales at the com-

[1] An address delivered at a meeting of the Social Science Association, at Norwich, 1873.

mencement of this year as a signal instance of the inability of trades unions to cope with the superior resources of employers when firmly united together. Without venturing to apportion to either of the contending interests its respective share of responsibility, it is clear that the ironmasters were alone in a position to know whether their business was sufficiently remunerative to make it possible to dispense with a reduction of wages; and it was stated by Mr. Crawshay that he had taken a contract for 2,000 tons of rails at £9 2*s.* 5*d.* per ton net, and that he lost money by selling rails at that price. The miners, however, were in the embarrassing position in which workmen are always placed whenever they are engaged in similar disputes. They had to struggle in the dark, and had no means of correctly estimating the profits of their employers. The responsibility of the executive council of the miners' union during the labour crisis in South Wales was immense. The miners connected with the union were about 10,000 in number; but, by their cessation from labour, 50,000 of their fellow-workmen, engaged in various branches of the iron trade, were kept out of work. The "strike pay" distributed by the Colliers' Union amounted to a total of £40,000, a sum quite insignificant by comparison with the amount of £800,000, which the men would have earned if they had continued at work; and the burden of sustaining a vast population proved eventually insupportable. In point of fact, the men were only enabled to continue the struggle by the assistance of the tradesmen of the district, and when at length the latter found themselves unable to continue the supply of the necessaries of life on credit, surrender was inevitable.

The re-action against the International Society in Belgium originated in a similar cause. In 1871, during the strike in Flanders, the society was unable to fulfil its promises of support, and it has consequently lost credit with the operatives, many of whom, as we are informed by Mr. Kennedy, have withdrawn from it. It was the same with the miners at Waldenburg, in Silesia, where 6,000 men went out on strike. After all their savings had been exhausted, they received a grandiloquent dispatch from the Central Council at Berlin, urging them to emigrate *en masse*. A few obeyed the advice. The majority who remained were compelled to surrender, being consoled by the assurance that the most valiant armies must sometimes yield to superior numbers, and that they had won for themselves the admiration of Germany.

Almost to the last, the originators of the strike in South Wales opposed the generally-felt desire to return to work. Never perhaps was the magical power of eloquence over a half-educated audience more conspicuously displayed than at the meetings held by the workmen towards the close of the South Wales strike. Men, who had gathered together for the express purpose of negociating a peace with their employers, were turned aside against their own judgments by the eloquent exaggerations of orators who were interested in the continuation of the struggle.

I now pass to the larger question of the rise in the price of coal which has recently taken place. It will be remembered that, on the motion of Mr. Mundella, a committee of the House of Commons was appointed in the last session to inquire into this subject. After a long investigation the committee reported, as might have been expected, that, in their judgment, the rapid development of the iron industry was the primary cause of the advance in the price of coal. It appears from statistics, compiled under the direction of the committee, that the total production of coal in 1869 was 107,000,000 tons, of which 79,000,000 were used in manufactures. The total production in 1871 was 117,000,000, of which 85,000,000 were used in manufactures. It will thus be seen how large a proportion of the total quantity of coal raised is consumed in manufactures, and specially in the manufacture of iron. In 1867, 567,000 tons of pig-iron were exported, 4,193,000 tons of pig-iron were converted into rolled iron, 1,317,000 tons of rolled iron were exported, and 28,331,000 tons of coal were used in the manufacture of iron. In 1872, 1,333,000 tons of pig-iron were exported, 5,390,000 tons of pig-iron were converted into rolled iron, 2,055,000 tons of rolled iron were exported, and 38,229,000 tons of coal were consumed in the manufacture of iron.

The committee rightly observe, in commenting upon these figures, that although the disturbance in the proportion between the demand and the supply of coal might not appear sufficient to explain fully the great rise of prices, yet a comparatively small deficiency in the supply of an article of paramount necessity may produce a disproportionate increase of price, through the eagerness of buyers competing with each other, each for his own supply.

Other reasons for the rise in the price of coal have been urged, and among these more especially the reduction in the hours of labour, and the great advance of wages. The advance in the wages paid to the miners is in truth extraordinary. In a large colliery in which I have an interest I will give the advance in the weekly wages of some of the principal trades. The weekly wages of hewers in 1869 were 24*s.* 5*d.*, they have risen in 1873 to 48*s.* 9*d.* The wages of timbermen in 1863 were 25*s.*; in 1873 they are 53*s.* 4*d.* Hawlers in 1869, 20*s.*; in 1873, 31*s.* 6*d.* Landers in 1869, 21*s.*; in 1873, 36*s.* 9*d.* Labourers in 1869, 15*s.*; in 1873, 24*s.* a week. The average of all the trades and employments gives 20*s.* 11*d.* for 1869, as compared with an average of 36*s.* 8*d.* per week in 1873.

A similar rise of wages has been established in other parts of the country, of which I have no personal knowledge. Wages have risen since 1870, 48 per cent. in Northumberland, and 50 per cent. in Durham. The requirements of the Mines Regulation Act have involved an additional expenditure, as estimated by some authorities, amounting to 12½ per cent. upon the cost of production. It was estimated by Mr. Pease that the total cost of working in the collieries with which he was connected had increased 50 per cent. between 1870 and 1872. Mr. A. Macdonald, the president of the Miners' National Association, confirming the opinion of Mr. Pease, estimated that the cost of getting coal in Northumberland had increased between 1868 and 1872-73, from 60 to 65 per cent., while the selling price had risen 120 per cent.

It might be easily made to appear that the rise of wages was the principal cause of the advance in coal. But my individual experience abundantly confirms the opinion expressed by the committee of the House of Commons, to the effect that the prices of coal which prevailed for years before the present rise commenced were so low that they did not afford a reasonable profit to the owners of collieries in general, or such remuneration as the workmen might, with regard to the hazardous and arduous nature of their labour, reasonably expect. The rise in the rate of wages has not, under the exceptional circumstances, been unreasonable; and it is certain that the real order of events has been, first, the rise in price of iron, then a rise in the price of coal, and lastly a rise in the rate of wages. On the other hand, though great have undoubtedly been the profits in the coal trade, it is a question whether the last two years have compensated the coal-owners for the former protracted era of stagnation, and, in many cases, of serious loss. The period of prosperity may continue for a year or two years at the most, but at the end of that time the influx of capital into the coal trade attracted by the present high profits, will infallibly lead to some reduction in price. New coal-pits are being sunk; old pits are being improved; more workmen are being trained in the business of mining. Hence we may look with confidence to an augmentation of the output, and to a sufficient supply for the ordinary demands of consumers. The insufficient profits of former days cannot be attributed to the unreasonable standard at which wages were maintained. The excessive competition in the supply of coal was the true cause of the unfortunate position of the trade.

Complaints have been urged as to the effects of shortening the hours of labour; and it is certain that if a comparison be made between the amount raised and the total number of individuals employed, a less quantity is raised per man now than in former years. It must not, however, be forgotten that high wages have attracted a great number of untrained hands to the coal pits. It would be presumptuous in me to express an opinion as to the precise number of hours which would constitute a fair working day in a coal-pit. Mr. Macdonald, who has had actual experience as a working miner, declares that the present earnings could not be obtained with less than eight hours of work a day, and that no man who laboured assiduously for that number of hours could work continuously six days a week at coal mining. It will be the duty of those to whom the miners are in the habit of looking for guidance to watch with care the course of trade. They know that the iron manufactures of this country can only prosper so long as we are able to sell our iron abroad at cheaper rates than those demanded by foreign producers.

There are some who think that a limitation of the hours of labour is in itself an evil. I cannot share in this view. Because some may make an unwise use of their newly acquired advantages, that is no reason for returning to a former state of things, when, in the general depression of trade, an undue pressure was brought to bear upon the working man. "No doubt," says Sir Arthur Helps, "hard work is a great police agent. If everybody were worked from morning till night, and then carefully locked up, the register of crime might be greatly diminished. But what would become of human nature? Where would be room for growth in such a system of things?"

The use of leisure requires education, and that education had not been largely given to the mechanics, the miners, and the puddlers of former generations.

Among various improvements which may tend to reduce the price of coal, we may look with confidence to the increased use of coal-cutting machinery as a substitute for manual labour, and

to the discovery of methods by which the consumption of fuel may be reduced.

Domestic consumption absorbs but a moderate proportion of the total quantity of coal used, but it cannot be doubted that, so far as it goes, it is wasteful. The inventor of an effective improvement in the form of grate now in common use will be a true benefactor to his fellow-man.

Already we have in the cooking stove for yachts the invention of Mr. Atkey, of Cowes, a highly successful apparatus. A letter from Mr. Vale, ex-President of the Liverpool Architectural Society, to the "Times" in August last, describes a cooking stove for a party of nine persons, and a crew of thirteen men, which measured only 1 ft. 9 in. by 1 ft. 4 in., and which was 1 ft. 9 in. in height, the actual fuel space being less than one cubic foot. Having weighed the fuel required in his yacht for one day's consumption, which was 47 lbs. of coke at twenty shillings a ton, Mr. Vale found that the cost per head per day amounted to less than one farthing.

But economy in the consumption of coal in the manufacture of iron is a far larger question than economy, however desirable in itself, in the consumption for domestic purposes; and, as an illustration of what may be achieved in this direction, I will quote some extracts from a letter from Mr. Bessemer, detailing the results which have actually been attained through his most valuable discoveries.

The average quantity of coal required to make a ton of pig-iron is about two tons of coal to a ton of pig; and, as pig-iron forms the raw material for the several processes of manufacturing both malleable iron and steel, we may treat the pig simply as the raw material employed, and consider only how much coal is required to make a ton of finished rails. About two tons of coal are required in order to convert pig-iron into iron railway bars.

To produce one ton of steel rails by the old process of making steel in Sheffield, a total consumption of 10 tons 8 cwt. of coal is required; and the conversion of iron bars into blistered bars occupies from eighteen to twenty days.

To make Bessemer's steel from pig-iron into steel rails requires about 5 cwt. of small coal in the form of coke to melt the pig iron in the cupola, 2 cwt. to heat the converting vessel and ladle, and say, 2 cwt. for the blast engine, which converts 5 tons of pig-iron into fluid cast steel in twenty minutes. Lastly, for rolling the ingots into rails, say 16 cwt. of coal, making a total consumption of 20 cwt. of coal in producing one ton of Bessemer's steel rails from pig-iron. Thus, common iron rails take 2 tons of coal; Sheffield cast steel rails, 10 tons 8 cwt.; Bessemer's steel rails, 1 ton 5 cwt.

But we must also consider other points in connection with these figures, in order to arrive at a correct estimate of the saving of coals effected by the introduction of steel as a substitute for iron.

Although the cost of Sheffield steel entirely shut it out of the market for rails, it must be borne in mind that it was extensively used for wheel tires, slide bars, piston rods, and other parts of locomotive engines; and here a saving of over nine tons of coal per ton of steel has been effected. Further, it must be borne in mind that at stations where rails are rapidly worn, the saving, by the use of steel as a substitute for iron, must not be simply estimated as a saving made on one ton of each material. For instance, at the London and North-Western station, at Crewe, the iron rails are so rapidly worn that they require to be reversed every four months, each rail being completely worn out in eight months. Bessemer's steel rails were first used at this station, and after being in constant use for seven years, they were removed in consequence of rebuilding the station, one side only of the rail having been used, and this was not quite worn out. During the seven years these rails were down 1 ton 5 cwt. only of coal had been employed in the production of each ton of rails used at this station; whereas ten sets of iron rails would have been entirely worn out in that period, each set consuming two tons of coals in its manufacture, or equal to twenty tons of coals for iron rails, as against 1 ton 5 cwt. of coals for steel rails; and those, when turned, would be equal to another seven years' wear on the side not used.

The above is, no doubt, an extreme case, but the same sort of thing goes on everywhere where steel is used, though in a less degree. It has indeed been admitted by competent persons that the rapid destruction of iron rails would have caused a complete collapse of the Metropolitan railways by continued interference with the traffic while removing the worn-out rails, had not steel been employed.

It should further be borne in mind that the extra strength of steel over iron admits of a reduction of one-third of its weight in all structures previously made of iron. Thus a further saving is effected of the fuel consumed for a given work.

The rapidity with which Bessemer's steel is coming into use will be appreciated when it is stated that the report of the jury at the London International Exhibition showed that the entire production of steel in Great Britain, prior to Bessemer's invention, amounted to 51,000 tons per annum, while the quantity of Bessemer's steel made in Great Britain during the twelve months ending June, 1873, amounted to 481,000 tons, or nearly ten times the amount of production prior to the invention. Had this quantity of steel been made by the old Sheffield process it would have consumed, according to the foregoing figures, 4,401,000 tons more coal than was actually employed in its production. Should this enormous increase in the manufacture continue, as it at present promises to do, in another five years we may have treble the quantity of steel made in this country with a corresponding saving of fuel.

It remains to consider how far the apprehensions entertained in many quarters for the future of the British iron manufacture are justified by actual experience. We are sometimes assured that Belgium threatens our ironmasters with serious competition. But in Belgium the ore must be carried 100 miles or more to be smelted. The coal-pits are worked in many cases with considerable difficulty. A Belgian workman does about half what an Englishman can accomplish in the same space of time. Sometimes we are told that we shall lose our position in the Russian market. The Russian Government are doing their utmost to encourage the manufacture of iron at home, but there is little demand for pig-iron in that country. Few Russians have had any experience in puddling. Skilled mill and forge men are scarce. Few of those obtainable have had any experience in the use of mineral fuel, and great difficulty is experienced in consequence of the objection of the Russians to piecework. Lastly, we are threatened with competition from the United States. The production of pig-iron in the States may now be estimated at 2,500,000 tons, an increase of 1,000,000 tons on the production of five years ago. But the ironmasters of the United States, although protected by a duty of nearly £3 a ton on railroad iron, have hitherto been unable to supply the entire demand at home. There cannot be a doubt as to the ultimate consequences of the comparative exhaustion of our supplies of raw material at home; but we may hope that the tariffs which now throw obstacles in the way of legitimate trade will in time be removed, and that, as Mr. Mattieu Williams has suggested, we may be enabled to avail ourselves of the natural resources of America for obtaining our supplies of raw material, just as we already derive large supplies of hematite iron ore from Bilbao.

The progress of the American iron works is the more creditable because great difficulties are experienced in obtaining a sufficient supply of labour. There is an engine building establishment in Philadelphia which is more extensive than any in Europe, and from which locomotives are supplied to Russia, in competition with all the makers in England and Germany. As an illustration of American ingenuity and enterprise which came under my immediate notice, on the occasion of a recent visit to the States, I may point to the Peabody Rifle Company's establishment at Providence, Rhode Island. During the Rebellion the company was fully employed in the manufacture of small arms. The cessation of the struggle put an end to the demand for rifles; but, with the fertility of resource which distinguishes American industry, the manual skill of a large body of workmen, especially apt in the production of tools or machinery composed of numerous small and interchangeable parts, and the valuable and ingenious plant belonging to the company, are now employed in the production of sewing machines. Three hundred machines are turned out every day, and the sale is constantly increasing. The wages of the 500 operatives employed are most liberal. The monthly pay-sheet amounts to 25,000 dollars, giving an average of 40*s.* a week throughout the factory. The success of the Peabody Company affords significant evidence that the cost of production is not augmented in equal proportion to the high rates of pay. At the time of my visit they were negotiating a contract for the supply of 100,000 rifles to the Roumanian Government, at the rate of 63*s.* per rifle; and they had to compete for the contract against all the makers of Birmingham and Liége. This company has also in prospect an order for 200,000 rifles from the Turkish Government. The success with which the Americans have utilized the most costly manual labour, by the invention of machinery, gives us ground for caution lest our old supremacy be shaken by the energy and talent of the New World, while it also gives us reason to hope that the effects of the exceptionally high rates of wages now prevailing may be mitigated by substituting, wherever it is possible, mechanical for manual labour.

Looking to the present condition of our iron trade, there is nothing to justify serious misgivings. According to the last report of the Commissioners of Customs, the average rate of the

value of pig iron exported in 1870 was £2 19*s.* 2*d.* per ton; in 1871, £3 1*s.* 8*d.*; in 1872, £5 0*s.* 11*d.* But the demand for pig-iron continued nevertheless unchecked. The increase in the quantity exported in 1872 over 1871 was 28 per cent. The increase in the price ranged as high as 108 per cent.

While the export of pig-iron attained to the figures I have quoted, the total increase in the exports of iron and steel manufactures did not exceed 6·7 per cent. Indeed, the manufacture of steel actually fell off from a value of £683,000 in 1871, to £623,000 in 1872; a result the more remarkable, as compared with the increase in pig-iron, because the price of steel had not advanced in anything like the same proportion with the rise in pig-iron. The price of the latter article had risen, as I have said, from £3 1*s.* 8*d.* to £5 0*s.* 11*d.* per ton; while unwrought steel had only advanced from £30 12*s.* 3*d.* to £32 18*s.* 7*d.* per ton, and steel manufactures from £52 8*s.* 1*d.* to £55 4*s.* 10*d.* per ton.

Hence it would appear that when once a demand has been created for an article of the first necessity, such as iron, it is not easily checked, even by a very marked advance of price.

The workman must, however, remember that when the course of trade has been changed, and consumers, alarmed by the high prices in our market, have been driven to look for their supplies in another, the position, once lost, is not easily recovered. The superiority of our artizans in skill and industry has assisted our manufacturers to compete successfully in the past. But the same success will not be maintained in future, unless our workmen continue, as before, to co-operate with their employers in their efforts to reduce the cost of production.

Perhaps no branch of industry has conferred greater lustre on our country than our shipbuilding, and the extensive use of iron for ships of the largest type makes it a point of great interest to ascertain how far the activity of our shipbuilding yards has been affected by the recent advance in the price of wages. I am informed by an eminent firm of shipbuilders that, shortly after the reduction in the hours of labour from fifty-nine or sixty hours a week to fifty-four, which took place at the close of 1871, an agitation was commenced amongst all classes of men for an advance in their rates of wages, which has been, in some shape or other, conceded to them, to the extent of from 7½ to 15 per cent. In reality this was the natural consequence of the reduction in the hours of labour, although at the outset the leaders of that movement professed that they did not seek to increase the rates of wages.

The reduced hours of labour increased the cost of production of all articles, and led to the necessity for an advance in the rates of wages. In point of fact, the advantage of the reduction in the hours of labour being conceded, on social and moral grounds the necessity for some corresponding advance in wages followed as a matter of course, and was, perhaps, not unreasonable. The two causes combined have resulted in an increased cost of production, so far as labour is concerned, of from 20 to 25 per cent. The cost of building first-class steamers and first-class marine engines has, in consequence of the rise in wages and materials, been increased from 30 to 40 per cent.

The actual diminution by the nine hours' movement in the amount of work turned out with a given plant should, in theory, be only in proportion to the reduced number of the hours of work, or, say, about one-tenth. It is in reality from 15 to 20 per cent.

From an eminent firm on the Clyde I learn that on riveters' and smiths' piece-work there has been an increase of 20 per cent. and 10 per cent. respectively in the last two years; but in fitters' piece-work there has been a decrease of 10 per cent. The price of first-class steamers in 1871 was about £24 per ton. At present the cost would be from 30 to 35 per cent. higher. The building of sailing ships decreased in 1871 and 1872, but in 1873 there has been an increase in the number built. The building of steamers has not been so brisk in 1873 as in 1871 or 1872, a marked falling-off in orders having taken place since the beginning of this year.

On the Thames I find that piece-work is at least 15 per cent. dearer now than in 1869 and 1870. The operatives who are employed in attending to large self-acting machines, which require little manual labour, are only working fifty-four hours instead of sixty hours, or, in other words, the machine is working six hours less out of every sixty. In point of fact, a loss of 10 per cent. has been experienced. Again, there has been a large increase of overtime since the nine hours' movement commenced. Wages for overtime are higher than for ordinary time. An hour and a-half's pay is given for every hour's work, and many men refuse to work unless a certain amount of overtime is given to them.

With the recent reports from shipbuilders it may be useful to compare the general progress of shipbuilding in the United Kingdom in the last ten years. The tonnage of the ships built increased from 328,000 tons in 1867 to 475,000 tons in 1872. There has been no increase in the registered tonnage in the interval, but the vast increase in the proportion of steam to sailing vessels will fully explain the apparently stationary condition of the mercantile marine, if tested solely by the amount of tonnage. It is equally assuring to find that, in the estimation of foreigners best qualified to form an opinion, the extent of our merchant navy excites profound admiration. M. Bal, director of the Bureau Veritas, in giving evidence before the French parliamentary commission of inquiry into the condition of the French mercantile marine, said that to him it seemed almost incredible that England, which has only 27,000,000 inhabitants, had 6,903,000 tons of shipping, whereas all the other maritime powers put together had only 6,648,000 tons.

Amid the many difficulties of the present time, the English employers may perhaps take comfort by looking abroad, where they will generally find that the same problems with which they have to deal are presenting themselves, and often in a still more aggravated form.

Passing from shipbuilding to engineering, I have ascertained that in an establishment on the largest scale, in which, by simplicity and uniformity of type, and by offering to the workmen the rare advantage of constant employment, the cost of production has been minimized to the utmost degree, the increased cost of production in 1871 over 1870 was, for wages, 2·73 per cent., and for materials, 2·59 per cent. Again, the increase in 1872 over 1871 was, for wages, 7·97, and for materials, 7·94 per cent., thus showing that the most liberal application of capital, the most ingenious machinery, and skilful administration, had failed to compensate for the great advance in the rate of wages.

I may also quote the following details from a report recently received from an engineering establishment with which I am personally connected. In reply to my inquiry as to the effect of the nine hours' movement in diminishing the amount of work turned out, I am informed that, while wages have been considerably advanced, no increased activity on the part of the men has taken place; indeed, less is done in nine hours now than was done in nine hours when ten hours constituted a day's work.

The rise of wages has been very considerable in the last two years. The price of locomotives has, in consequence of these various causes, increased from 25 to 30 per cent. An ordinary passenger engine, which might have been built in 1871 for £2,200, cost in 1872 £2,400, and in the present year the price would be £2,600. In modern marine engines the cost of materials and labour is about equal. An engine which might have been built in 1871 at £40 per horse-power, would have cost in 1872 £46. In the present year the price has advanced from £55 to £60 per horse-power.

Lastly, I am informed, in reply to an enquiry on the subject, that there is no appreciable difference in the dress or appearance of the working man in the town in which my works are situated, that there is more money and more time spent in the public-house, and that time in the morning is not so well kept now as it was before the nine hours' movement commenced. It is suggested to me that the improvement in wages and the shortening of the time came too suddenly upon the working man.

Listening to these plaintive utterances, it is difficult to overcome a feeling of depression as to the future of our mechanical industry. But, when we look to the progress made in the past, there is no ground for discouragement. The value of our exports of steam-engines in 1866 was £1,760,000; in 1872, £2,995,000. The value of our exports of machinery of other sorts was, in 1866, £2,998,000; in 1872, £5,606,000. The past has been prosperous, the future mainly depends upon the conduct of our artizans.

At a time when our own manufacturers are driven to despair by the inexorable demands of labour, it may be well to examine the situation of affairs among our continental rivals. Valuable materials for such investigation are furnished to our hands by the recently-published reports of our Secretaries of Legation, and by a most important pamphlet prepared by Mr. Redgrave. From these authorities we learn that in the last ten years wages at Verviers, a great centre of industry in Belgium, have gradually increased 20 per cent., and that the working hours are shorter than they were. At Ghent the rate of wages has risen 60 per cent. in the last fifteen years. The average prices of the necessaries of life show an increase in Belgium of 50 per cent. in the last thirty years. In Prussia Mr. Plunkett states that there is a universal tendency to reduce the hours of labour and to raise the rate of wages. In the spinning and weaving factories in Silesia, according to a statement of Dr. G. Reichenheim, quoted by Mr. Plunkett, the increase in the rate of wages in the last ten years has been about 30 per cent. for female weavers, while in the case of male labour it is more than double. The same complaints are made, which we hear in this country, as to the effect

of higher pay in rendering the operatives less careful in their work and more insubordinate than formerly.

In Belgium all the factory occupiers are of opinion that the English operatives are far superior to the Flemish. An Englishman, being better fed, possesses greater physical power, and produces as much work in ten hours as a Fleming in twelve. There is no regular exportation of Belgian textile fabrics to Great Britain, and although the rates of wages are lower and the hours of labour longer, English manufacturers have but little to fear from Belgian competition.

Mr. Gosling says of the Swiss workman, that he is, in most respects, inferior to the British workman, that he has neither the physical strength nor the energy and activity of the latter. The average length of a working day in Switzerland is twelve hours, exclusive of the time for meals. The general tendency is to a reduction of hours, and laws have been passed limiting the length of the working day in some cantons to twelve hours. These changes are, however, almost entirely due to the efforts of local politicians. A proposal of this nature recently made in Zürich, and sanctioned by the Cantonal Legislature, was eventually thrown out by the popular vote.

At Rouen, Mr. Redgrave found no strong desire for a diminution of the hours of labour in the cotton factories. The operatives were chiefly solicitous for a rise of wages. In this regard the workpeople of all countries seem to entertain similar feelings. Messrs. Bridges and Holmes, in their report on the condition of operatives in English factories, say that the workpeople are by no means unanimous. Among the women especially many are apathetic, and some are positively opposed to a limitation of the working hours. The French manufacturers insist strongly on the greater cost of production in their country as compared with England. They estimate that the cost of wages per week for the hands employed upon 10,000 spindles would be £59 10*s*., while in an English factory the corresponding amount may be set down at £41. "The value of the English workman," says Mr. Redgrave, "still remains pre-eminent, although the interval between him and his competitors is not so great as it was; he has not retrograded, but they have advanced. We see too much of intemperance in England, but there is much reason to complain in Belgium and the manufacturing districts of France, where the cheapness of intoxicating liquors is a fearful temptation to the working classes."

The progressive development in the skill of our factory operatives has been clearly shown in the comparison instituted by Messrs. Bridges and Holmes of the tasks now performed, with the amount of work allotted to the hands, as ascertained by the Factory Commission of 1833. Messrs. Bridges and Holmes estimate that the proportion of spindles in 1833 was 112 to each hand, and that the corresponding number at the present day would be 517 spindles. Then with regard to the speed of the mule, more stretches are now made in 10½ hours than formerly in 12. In 1848 a female would have had only two looms, now she will attend to four. The speed of the power looms in 1833 varied between 90 and 112 picks a minute, it now varies between 170 and 200.

In England we are happily doing away with the great evil of employing young children in our factories. All the chambers of commerce in Belgium unite in deploring the increasing moral and physical degeneracy of the working classes, which they attribute to the premature employment of children. In 1866 out of their total population of 4,827,000, more than one-half were unable to read or write. The necessity for the employment of children is best proved by the description given by Mr. Kennedy of the position of the Belgian operatives at Alost and Tirmonde, where a first-class hand earns £28 a year, whilst the smallest sum on which a man can exist is £20 a year. Indeed, existence is only made possible by the employment of children in factories, and by the possession of a small garden in which vegetables are raised.

In the English factories a larger number of women are employed than in factories abroad, and the Association of Employers, though differing on almost every other subject from Messrs. Bridges and Holmes, suggest that women should be excluded from factories for three months after their confinement. Great evils have been found, by experience, to ensue from the too early return of the mothers to factory labour. Let us venture to hope that another session of Parliament will not be allowed to pass by without placing on the statute-book a legal prohibition against a practice which is universally condemned by those most competent to form an opinion.

In examining the various circumstances which tend to raise the price of labour in England, the prevailing high wages in the United States, and the increased facilities for emigration must ever be kept in view. The nominal rate of wages in America may indeed frequently convey a delusive idea of prosperity, yet it cannot be doubted that in the main the thrifty, skilful, and industrious artizan has larger opportunities of advancement in the New World than in the Old. At Lowell, near Boston, I ascertained that the working hours were sixty per week, and that no indication has yet been given of a disposition among the operatives to reduce the hours. The workpeople are paid as far as possible by the piece. The monthly pay-sheet at the Merrimac Mills, where 2,600 hands are employed, amounts to 75,000 dollars, which gives an average of thirty dollars a month, or 30*s*. a week. The majority of the workpeople are Americans, but there are many from Canada and the old country. The proprietors of the mills have established several lodging-houses for the unmarried women whom they employ. At each of these houses some thirty women are lodged. The house is placed under the supervision of a respectable matron. The cost of living is 3½ dollars a week, and female operatives can earn from 14*s*. to 16*s*. a week over and above the cost of their board and lodging. The men pay for board 2*s*. a day, and their wages vary from 7*s*. to 10*s*. a day.

At the Lonsdale Company's cotton mills, near Providence, in a factory containing 40,000 spindles, one man attends to 1,408 spindles, and in weaving, one weaver attends to from four to six looms. In England, the proportion would be, on the average, one hand to every three looms, working at a higher speed than they have attained in America. Male weavers were earning from 44*s*. to 52*s*., and female weavers from 40*s*. to 44*s*. weekly. Spinners earn from 4*s*. to 6*s*. a day. Women pay for board and lodging in lodging-houses provided by their employers, 12*s*., and men 16*s*. a week. The operatives earning these wages are better able to save money than the operatives in our own country, and many of the hands at the Lonsdale Mills have £1,000 to their credit in the savings' bank. At the great Harmony Mills at Cohoes, near Albany, where 4,000 hands are employed, two-thirds are immigrants to the States, principally English and Scotch, although there are many Germans and some French. The general wages are for women from 3*s*. to 6*s*. a day, for men from 6*s*. to 10*s*. a day. With regard to the cost of living, I was informed that, assuming a female operative earns 28*s*. a week—by no means a high average—she has 16*s*. a week to spend on dress and luxuries. At Cohoes a weaver attends to four, five, or six looms, but the machinery is not worked at so high a rate of speed as in Lancashire. The mule is never worked at a speed exceeding three stretches a minute.

It has been already pointed out that in England we have to contend against competition of two kinds—against the cheaper labour of the continent on the one side, and against the superior natural resources of America on the other. We occupy at the present time a highly favoured position, which has been attained not merely by the energy of our workmen, but by the administrative skill of their employers, and the gradual accumulation of an ample capital in their hands. But the race with other great manufacturing countries is very close. The Swiss have entered into competition with our own manufacturers, both in the home and foreign trades. The exports of textile fabrics from Switzerland, as we learn from Mr. Gosling's report, have risen from £12,485,000 in 1860, to £26,464,000 in 1871, an advance of 112¼ per cent. In this total their exports to the United States have risen from £509,000 in 1862 to £2,159,000 in 1872, in other words, over 324 per cent. In cheap silks and ribbons the Swiss are able to compete with the British producer in the English market; and, to sum up the case in the words of Mr. Gosling, "The advantages of Switzerland in competition with Great Britain are the use of water power as a substitute for steam power, to the extent of upwards of 80 per cent., low wages, long hours of labour, and a minimum expenditure for management." On the other hand, as an inland country, Switzerland has to pay heavy freights, the workmen are inferior in activity to our own, buildings for machinery are more costly, and from want of capital, production is on a smaller scale than here. The balance, however, seems to be greatly in favour of Switzerland, and cannot fail to become greater from day to day.

Such being the case as regards textile industry, Mr. Lothian Bell, one of the highest of our authorities, has recently pointed out that in ores of the finer descriptions the resources of the United States are unlimited, while in coal our own wealth, is, in comparison, poverty. There is but one bar to the boundless production of minerals in the New World, viz. the want of hands to manufacture them. Moreover, the United States, not content with their natural advantages, impose an almost prohibitory tariff on our exportations. There is a party in America opposed to protection, but hitherto the superior organization and greater determination of the manufacturers interested in the maintenance of the tariffs has overpowered all opposition. At the last annual meeting of the American Institute of Mining Engineers at Philadelphia, the Honourable D. Kelley, who delivered the opening address, maintained that by its dereliction of duty in not protecting the labourer of Great Britain against com-

petition, the Government of this country have fostered anarchy in Ireland, while the life of the labourer in England and Scotland has been robbed of all its joys. "The millions of sturdy men," he declared, "represented by Bradlaugh, Odger, Joseph Arch, and the travelled and humane patrician, Sir Charles Dilke, know that the world owes every man a living, and that it is only by protection that the means of living can be secured to the people." So long as such a feeling prevails, there is little hope of our iron-masters obtaining free access to America.

Our artizans may believe that the profits of former days were so large that employers can afford to pay the present rates of wages without raising their charges to the consumers. There is but one means by which this fallacy can be exposed. The workmen must become to a certain extent their own employers. In a co-operative establishment, created in part by his own hardly-earned savings, the handicraftsman will find himself called upon to apportion equitably the earnings of his business between labour and capital. In this double relation he will learn how great are the difficulties which beset the employment of capital in productive industry in a country in which competition is so keen as it is in England. In no other country does capital command so low a rate of interest, and be it remembered that money is cheap only because it is abundant, and that accumulations of capital have been made, not because profits have been large, but because the employers of labour in this country, as a class, have been distinguished by their frugality, their perseverance, and their enterprise. The co-operative principle, in its application to the business of distribution, has been already most successfully developed. My object, however, is to encourage workmen to create co-operative establishments for the purposes of protection. The accumulation of the necessary capital is an obvious difficulty. But as wages were never so high as at present, so this obstacle can be more easily surmounted than at any former time. Some men may object to recognize the special responsibilities of a fellow-workman, holding the office of manager of a large business, by giving a proportionate salary. It is because the recognition of authority is essential, whenever anything practical is to be done, that the International Society has shown such uncompromising hostility to the co-operative principle. The denial of any reward for superior intelligence or industry is the first article of its catechism. The absurdity of attempting to combine the energies of the men for any definite object, without placing a competent chief at their head, must be obvious to every thoughtful mind. The argument of Mr. Carlyle on this subject was admirably effective. "Ships," he said, "did not use the ballot box at all, and they rejected the phantasm species of captains. Phantasm captains with unanimous votings! These are considered to be all the law and prophets at present. If a man could shake out of his mind the universal noise of political doctors in this generation and in the last generation or two, and consider the matter face to face with his own sincere intelligence looking at it, I venture to say he would find this a very extraordinary method of navigating, whether in the Straits of Magellan or the undiscovered sea of time."

English workmen are less easily deluded by tall talk and sophistry than the more excitable populations of the Latin race, and I would earnestly invite them to apply their practical sagacity to the difficult yet hopeful experiment of co-operative industry. The first thing to be done is, to save something from their present high wages. Forethought is an especial duty in a period ot prosperity. At no distant time the progress of our commerce may sustain at least a temporary check. It will be sad indeed if the receding tide leaves multitudes of our highly-paid workmen behind, without any provision to meet a time of adversity.

In closing this imperfect review of the labour question. I must repeat the old familiar axiom, that the price of labour, like that of every other commodity, must mainly depend upon the relation between supply and demand. The wages of skilled workmen have risen, because skilled workmen are scarce. How shall we increase their number and improve their skill? My answer is, by bringing recruits into our industrial army from a class of society which has hitherto exhibited too strong a prejudice against manual labour. The same aversion to handicraft of every kind exists in the United States and Canada. In America a skilled workman earns 30 dollars, a clerk only 15 dollars a week; and while it is almost as difficult for a clerk to obtain a situation in New York as in London, a skilled workman can always command employment. It is unnecessary to dwell on the evils which must ensue from a disproportionate increase in the non-productive classes of the community. Lord Bacon has truly said, that a population is not to be reckoned only by numbers, for, a smaller number that spend more and earn less, do wear out a greater number that live lower and get more. My father's advice was often sought by parents anxious for the future of their sons. His counsel always was, that a young man whose destiny it must be to make his way, unaided, through the world, should begin by learning a trade. It is a laudable ambition in a parent to endeavour to raise his family to a better station in life. He cannot bestow on his children too high an education. But a wise man will be on his guard lest the enjoyment of such advantages should render those occupations distasteful which afford the most secure and ample livelihood to those whose lot it is to labour. When justly appreciated, the condition of the skilled artizan should be as much esteemed as that of any other class of the community. He whose life is passed in performing such needed services for his fellow men, whatever his special calling, holds an honourable station, and social dignity will ever be most effectually maintained by those who are the least dependent upon the favour of others.

THE RIBBON MANUFACTORY OF MESSRS. GERENTET AND COIGNET, AT SAINT-ETIENNE.[1]

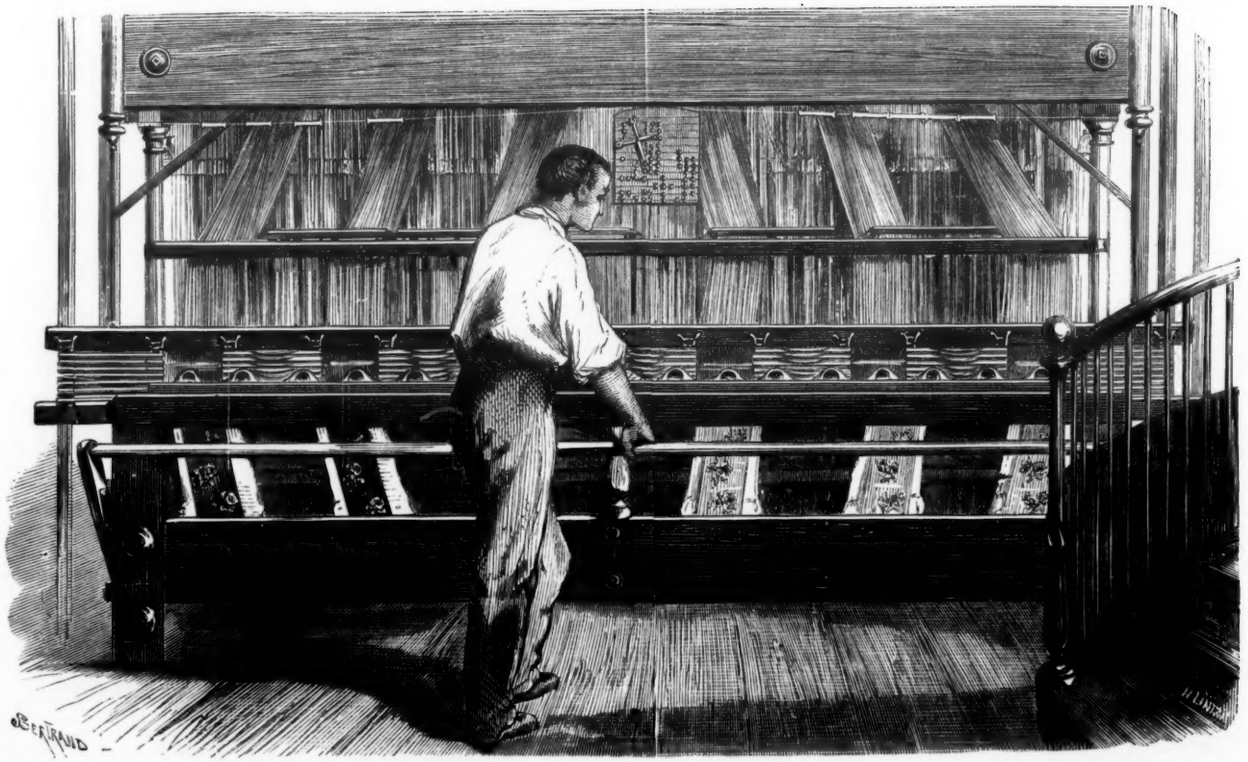
THE firm of MM. Gérentet and Coignet, signalled out by the decision of the last great exhibition at London (1862) as worthy of being taken as the type of the ribbon factories at Saint-Etienne, is far from being the oldest in the town. Founded in 1848 by two employés of the firm Colcombet, it appeared neither at the Exhibition of 1851 nor at that of 1855, and yet to-day it is looked upon with more favour than any other. Perhaps next year it will be otherwise, and another house will be in vogue—for this depends entirely on the fancy of purchasers. The ribbon industry is essentially one *de luxe*, and consequently submitted to every caprice of fashion; the most ancient commercial connections, the greatest efforts in manufacture, are worth nothing if the products do not sell; and as a ribbon is never indispensable, it never sells if it does not please, while it is sold at a very high rate if its shades and novel patterns are rapidly accepted by the taste of the day. To seek incessantly for what in some six months' time will take the fancy,—for at least six months is needed to design the compositions, fix the colours, dream over the combination of threads, and obtain generally a result very far indeed from the desired ideal—to make it and put it on sale, and to see, if one is happily crowned with success, one's product immediately imitated by inferior manufacturers—such is the unenviable lot of the ribbon manufacturer of Saint-Etienne.

This constant uncertainty as to result is one of the most legitimate causes of the manner of fabrication which obtains at Saint-Etienne, in spite of the numerous disadvantages of labouring to satisfy fashion. Why, in short, should they spend millions of francs to establish vast workshops, including weaving, dyeing, spinning, and finishing, when they have no power of knowing whether in the following year the wholesale merchant in Paris will not disdain to give his orders? Perhaps before foreign competition they will be obliged to lower the prime cost of the whole of the current manufactures, to have recourse to mechanical engines, and consequently to erect large establishments; but for the fabrication of fashionable goods, which are often of great complication, containing sometimes the finest gauze and the thinnest satin in the same band of stuff—when threads of all dimensions have to be united together, adding to the taffetas gold and silver, velvets and plush, and even lace work, there is often no great advantage in changing the actual processes, although their imperfection may be patent to all the world.

In three centuries only the ribbon trades, installed originally at Saint-Chamond, spread themselves through the *arrondissement* of Saint-Etienne, and ended by choosing the town itself as a centre, creating, in the year 1605, the brotherhood of ribbon workers. During these three centuries the fabrication of ribbons has taken a considerable increase, due to the especial intelligence of the inhabitants of Forez, one of the best endowed districts of France in an industrial point of view. A great number of the improvements in the different branches belong to the people of Stéphanois; but they did not invent everything, and many capital improvements are due to their Swiss and German brethren;—among others the bar-loom, brought from Switzerland, in 1756, by M. Flachat, of Saint-Chamond, and the economical processes for fining velvet introduced in 1775 by Roland de la Platière on his return from Crefeld.

The application to the bar-loom of the Jacquard machine, and of the various improvements derived from it, either by mechanicians of Saint-Etienne or by the ribbon workers them-

[1] Translated from M. Turgan's "Les Grandes Usines."



LOOM FOR WEAVING FIGURED RIBBONS.

selves, have resulted in constituting an admirable working instrument, of which further on we will give a description, and with which a skilled workman is able to make everything, from simple taffetas to elaborate portraits. All the manufacturers at Saint-Etienne are able to supply their hands with these admirable instruments, to go to the same spinners to purchase their raw silk, to the same dyers to have them coloured, and to the same specialists to have them *moiréd*, figured, and rolled; and the only difference in the ribbon itself rests in the invention of its shades, the blending of its threads into bold, and especially novel, composition of all the parts—and it is precisely in these that the firm of Gérentet and Coignet excel.

The chiefs of this house, able designers themselves, have the additional aid of M. Rebourg, who, according to their indications, composes ornaments varying incessantly in style and arrangement; sometimes these are purely fanciful compositions—Byzantine, Indian, Oriental, Chinese; at others of birds and animals, more or less approaching Nature; the commonest ornaments, and generally the most successful, are borrowed from flowers, which form *par excellence* the ornamental Fatherland. There are no flowers and leaves, the forms and colours of which, vary them as we will, do not produce an agreeable effect. Buds, corn-ears, fruits even, wherever employed, are not unsuitable for composition.

Birds, again, some species especially, lend themselves very readily to the fancy of the designer; quadrupeds which are able to find suitable place in an ornament are few and far between, and unless we go in for monsters like the Chinese, it would be preferable to renounce this order of Nature altogether, or at least to reserve woven figures of this sort to celebrate a national victory. Thus, a figure of Gladiateur upon parti-coloured ribbon of red and blue would have been a happy idea, and have enjoyed a large sale in the June of 1865.

As to the human figure, the reproduction of which has this year played an important part in a great number of compositions, it appears to us to be altogether irreconcileable with the use to which it is put. Without going so far as the Convention, which forbade the Gobelins and Savonnerie manufacturers to reproduce the image of man upon their weavings and tapestries, as being an indignity to the majesty of our figure, we should certainly prefer, more especially for ribbons, the selection of any other ornament. To us it seems impossible, at all events in France, that this sort of production should have any result more durable than a certain superficial success; nevertheless at this moment a large number of looms are manufacturing ribbon upon which are represented men, women, and children, as busts or on foot, alone or in combination with flowers and other ornaments. The profile of Cæsar crowned with laurels, among others, is repeated in a series of medallions, which are a tolerable success, but, according to our way of thinking, altogether out of place upon a ribbon. It would be scarcely worse if an antique cameo of the finest workmanship were taken from its glass case and used to decorate a modern beauty's toilet—nay, it stands to stronger reason still that these human figures, necessarily woven incompletely, in spite of all perfection of workmanship, should remain always as models of conquered difficulties in the recesses of a museum or an exhibition.

Whatever may be the nature of the design, a practical application is given to it by the card-setter, who transfers it, while enlarging the size, to a chequered sheet; this sheet assists the stamping-out machine to prepare the cardboard sheets for the Jacquard machine. The warps are made in the central establishment under the eyes of the superintendents; the threads composing them consist of organzines thick enough to support the strong tension necessary to the weaving; the warping requires an extreme attention, especially in the case of ribbons which are to include different kinds of web and different colours of warp.

The warping mills, of which we present an illustration, are situated in a handsome workshop. Each warping mill is composed of a "bank," a frame slightly inclined and arched, fixed at its two extremities into a wooden frame; it bears a variable number of bobbins, among which are divided the organzines destined to form the web. Parallel to the bank is placed a vertical divider, on which each warp revolves when it is made; the workwoman with her left hand moves a crank, which transmits the motion to the divider, and with her right hand she guides the passage of the threads between the glass teeth of a kind of large toothed comb.

The warps prepared in the divider are then rolled upon large bobbins, called blocks, belonging to the master-weaver, who is entrusted with the making of the ribbon; the threads of weft are not twisted and doubled like the organzines of the warp, but are more or less natural threads, more or less twisted, according to the nature of the tissue desired.

The master-weaver receives what is called a "*chargement*," that is to say, all that is necessary for the execution of the number of pieces of ribbon that the manufacturer has ordered—cards, warps, wefts, &c. Registers well kept, and tolerably complicated in their multifarious accounts, indicate the weight and nature of these prime materials, as well as the conditions the master-weaver has to fulfil.

The workmen who execute the articles *de grand luxe*, such as those of the house of Gérentet and Coignet, are in general scattered within only a small radius from the business centre, though some number of them live in the suburbs of the town, some even in houses belonging to themselves or constructed specially for them. The workshops have large windows, admitting much daylight, and necessarily very lofty, for the fitted loom of a Jacquard machine requires a space of no less than six metres high by five metres broad—a necessity that is very conducive to the well-being of all the workpeople.

The looms, two oftenest—sometimes three and four at most—are placed in the same room under the direction of the master-weaver, to whom they almost always belong.

The loom we herewith represent is the most complete of all. It belongs to M. Clair, who is the very model of a ribbon-weaver. This gentleman was sent to the London Exhibition of 1851 by the Saint-Etienne Chamber of Commerce, and received a medal at the Paris Exposition of 1855. To his kindness we owe this explanation which permits us to summarily describe the process of these complicated looms.

The frame of the loom is composed of strong beams at right angles, supporting a Jacquard machine, to which are connected the leaves as well as the levers which are required to heighten or lower the swivel of the shuttle which moves the apparatus forming the driver of the ribbon loom (*chasse-navette*). Behind the loom rise pegs, and fixed horizontally on these pegs the big bobbins, bearing the warps, are placed; the threads of the warps are directed vertically upwards, so as to pass through a series of pulleys, from which they vertically descend to be bent at right angles under the glass pegs, and are then directed horizontally towards the front of the loom. In this horizontal direction they at first traverse a box-wood comb, known as the "large comb," then through the mails, little rings of glass; from these the threads of the warps are passed through the teeth of a steel comb fitted on to the swivel; and, after being submitted to the action of the swivel and the shock of the shuttle, they are again bent at right angles, so as to descend vertically, and are rolled round a large bobbin, and the first stage of the ribbon is complete.

To maintain these threads at a suitable degree of tension, each fragment of the warp passing over the upper pulleys is obliged to bear, by means of a third intermediate pulley, a weight varying according to its presumed resistance. When we saw M. Clair's loom it was supplied so as to make at one and the same time six pieces of about twenty centimetres broad, the warp of each piece bearing a weight of some eighty kilogrammes, which was nearly five hundred kilogrammes for the whole loom.

As each warp is composed of about 2,000 threads, it was in the work under execution necessary to pass the thread of the false warp 12,000 times through each little glass ring and between the teeth of the two combs; then to fasten one by one over the weaver's beam each thread of the true warp to each thread of the false warp; in the same way, too, it is necessary to set the cards, the beetling cards, and all the accessories of the Jacquart machine—operations that render the process very costly, and remunerative only when the loom is set for a large number of pieces of the same size and the same shape; in this case they connect the threads of the piece to be made with the ends of the piece already made, and these follow the same round as their predecessors.

During the course of weaving, each time that the tension weights on the warp (comparable to those of a clock) attain the top of the loom the master-weaver is compelled to stop the work, withdraw the bobbin from the pegs that hold it, and supply the weights with a new length of thread from the warp. This complicated combination, replaced in other establishments by a weaver's beam which unrolls during the manufacture, is necessary by the different thicknesses which the different dyes give to the thread, which compels the workman to exert a constant watchfulness over his thread in order to obtain the same breadth of stuff.

The warp being set, it is necessary to pass, by means of the shuttle, the train which shall complete the ribbon. M. Clair's loom is arranged so as to employ from one to six shuttles; to the swivel are fixed the shuttle-holders, one between each piece and one at each extremity; these shuttle-holders have each of them six cavities, in which, according to the requirements of the work, they set the *corps de navettes* (a division of the leaves

made to facilitate the drawing of the warp), to which are hooked the *avant-de-navettes*, or fore-shuttles, bearing the colours required by the design. When there is no ornament in the design, and it is a question merely of making a plain ribbon, they use only one shuttle, and the swivel descends low enough to allow the first groove of all the shuttle-holders to be in the same plane as the inclination of the threads; it is then merely the process of the ordinary weaving loom, only the shuttle is not thrown in the same manner, and the arrangement by which it is worked, although not so rapid, gives a perfect regularity to the work. When they deal with ornaments the Jacquard machine lowers the swivel to the level of the second, third, fourth, fifth, or sixth groove of the shuttle-holders, in which the workman places the *corps de navettes* (the divisions made to facilitate the drawing of the warp).

By a pinion-jack each shuttle, from the second to the fifth rank, is moved by a transmission ingeniously obtained from a little spindle bearing cogged wheels, which act horizontally in the same manner as the teeth of the pinion-jack act vertically; the grooves are bored laterally in the body of the shuttle, instead of being cut out from the upper surface. The sixth and last row of shuttles is conducted by what they term a saw (*scie*); this is horizontal, and like the saw on the first row, only the teeth are placed upwards instead of downwards. To give the pinion-jack, formerly made of metal, more suppleness, they now make it of thin slips of walnut wood covered with leather, in which the teeth are cut. The loom itself receives its motion from a long horizontal hand-bar placed behind it, and worked by the ribbon-maker, the motion being transmitted by connecting rods and crutches to the other parts of the machine.

The *avant-de-navette* (or *fore-shuttle*, as we might call it) is an ingenious little apparatus intended to maintain the tension of the threads, facilitate their proper passage, prevent their entangling and consequently breaking. Little spiral metallic springs

Warping Frame.

hidden inside the wood work, and terminating in small glass rings, hold, though yielding, too, very readily, the thread of the weft, which has much less resistance than the thread of its warp. It unrolls them regularly during the course of the shuttle, the motion of which deposits it gently at the bottom of the angle formed by the intercrossing of the warp, instead of throwing it violently, as is generally done in weaving. Broad at its base, so as to be hung to the body of the box, to which indeed it is solidly fastened by means of cramps, its front is thinned almost to an edge, so as to penetrate to the bottom of the triangular space, which is extremely fine. By this means they are able to change the colours indefinitely without unsetting the loom; each thread of the weft might be different to the preceding.

On this loom M. Clair makes his masterpieces; but although the labour is effective for six pieces at the same time, the process seems very tedious to persons accustomed to watch the mechanical looms on which cotton or even cloth is woven. Sixty strokes of the bar a minute is a maximum rarely attained in the most active work; what with the changes of the spindles, the fastening of the threads of the warp, and the different manipulations necessary, the loom itself is in actual motion scarcely more than three hours a day. Thus, with these impediments for ribbons highly figured, it requires a good average of three days to finish one piece, that is to say, six metres of stuff. It is true that this material sometimes contains in a space of twenty centimetres taffetas and gauzes and satins and velvets, and ornaments embroidered in relief, and that it is often bordered with fringes, or laces, or galloons, the arrangements of which may vary infinitely. In certain cases even, as we saw at M. Gérentet's, the ribbon is of embroidered taffetas, woven upon a warp of a single colour, and bordered with plush and satin figures obtained by means of a printed warp.

The ribbon of printed warp (*à chaine imprimée*) is a very taking variety of ribbon of recent invention; the warps are laid smooth, and then they receive a printing precisely as if they were finished stuffs; they are then worked up with either taffetas or

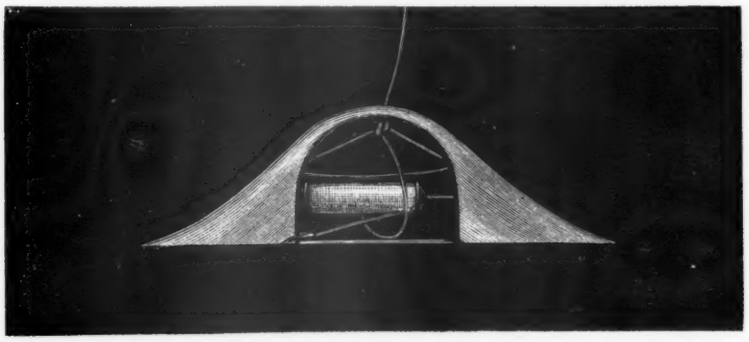
satins, and thus very economically a most satisfactory result is obtained, especially for satin. The thread of the warp being worked seven times causes the thread of the weft to almost entirely disappear, while in the same way the taffetas, presenting a thread of the warp for each thread of the weft, leave the weft visible, and yield a strange appearance by the interposition of white thread over coloured thread. We saw last year, at Messrs. Gérentet and Coignet's, a magnificent bouquet of flowers on a white ground executed in satin upon a printed warp. We regret that fashion has not favoured this kind of ribbon, destined to produce the most beautiful effect, especially, as we said before, upon satin.

To produce plushes in various designs, imitating either fur or the feathers of birds, especially of the peacock, they imprint on a warp the ornament they wish to reproduce, only on a wider scale, and they weave it in satin ; and by means of the shortening of the threads, caused by weaving, the figure is formed more or less exactly as the imprint was well or badly calculated.

This satin, worked with thick silk threads, after being woven is sent to Firminy, where a population of women, consecrated to this labour, cut every length of the thread with little special tools worked with the hand. The plush then is raised or left flat, according to the nature of the thread employed, and the close or loose texture of the satin. The most satisfactory results are thus obtained. We possess a charming combination representing, on taffetas, a peacock embroidered in relief, accompanied on each side of the ribbon with a plush border, happily imitating the beautiful iris eyes which glitter at the end of the peacock's feathers. A large quantity of ribbons, bordered with bands of fur (capitally imitated), will be used this winter as trimmings, not only for hats, but also for dresses and wrappers.

We can scarcely imagine to ourselves the number of different patterns, some very successful, others less so, that we have seen displayed on the counter where the employés of Messrs. Gérentet and Coignet measure, fold, roll, and pack their ribbons ; a minute enumeration and description of them would be certainly interesting, not only as a satisfaction to curiosity, but rather as a proof of the incessant activity and creative genius displayed by the manufacturers of Saint-Etienne. However, we will not betray their secrets, for the campaign is scarcely commenced as yet, and the merchants who have commissioned such and such kinds of altogether novel ribbons have a great interest in preventing the disclosure of their ideas, either at home or abroad, before the wholesale sales have been effected. The house of Gérentet and Coignet does not only manufacture *grands façonnés*, but with equal success *simple façonné* and the finest quality of *unis de fantaisie* in vogue at present. To maintain an incontestable speciality in these *unis* of the first quality, there is need of further efforts in inventing new patterns. During the present crisis of the silk trade, it is difficult to obtain really satisfactory qualities of the material ; on the other hand, to resist the exorbitant prices now asked requires a firm will and a careful watchfulness ; and to select shades and tones, in the midst of all the novel varieties that chemistry every year presents us, demands a prompt and certain decision. In the *unis* a shade which becomes fashionable insures an immediate sale, and an immediate sale is everything in an industry where all novelty changes from six months to six months.

The ribbons *grands façonnés* do not require a finish ; the precautions with which their manufacture is surrounded, and the nature of their tissue, made generally in simple net work, alone fit them for sale.



AVANT-DE-NAVEITE (FORE-SHUTTLE).

The finishing workshops, common to all the manufacturers of Saint-Etienne, give the last figuring to the different kinds of ribbons which are to receive them. Most of these figures are impressed by rolling ; thus moiré is obtained by passing the stuff between cylinders ranged with various cuttings ; satin, on the contrary, between smooth cylinders, the action of which compresses the threads of the warp, and gives them the polish peculiar to this beautiful material ; in some special cases the ribbons, before being rolled, are passed through a bath of starch or gum. Messrs. Gérentet and Coignet employ only this latter process. A rigid inspection of the completed products, both on their return from the houses of the workmen and before their sale to the purchaser, eliminates all defective pieces, and maintains the high reputation of a firm, the amount of whose business is very considerable.

By an incessant competition with foreign nations the French manufacturers have attained such a superiority that 130,000,000 francs worth of ribbon are exported from our country every year, Saint-Etienne contributing nearly 100,000,000 of the total amount.[1]

In spite of the recent years of crisis experienced by the Saint-Etienne manufacturers, the district still contains about 14,000 looms, fitted with a Jacquard machine ; all, it is true, are not working, nor are all prepared for figuring, but an expected revival in business would bring forward a large number of excellent machines and of most intelligent workmen to handle them.

More than 40,000 persons—manufacturers, clerks, dyers, reelers, warpers, wefters, weavers, designers, glazers, rollers, cutters, folders, and packers, divide the millions produced by this altogether luxurious industry, which would bring a very considerable profit to some, and large salaries to others, if artistic and industrial property could only be better defined and more rigorously protected. But it is easy to imitate in inferior materials, in cheaper colours, in miserable tissues, designs established primarily with all the sacrifices that have alone rendered them successful ; and it is not only by competition in sale that these inferior goods are hurtful, but more especially by the discredit they bring upon the fine stuffs. An original and altogether novel invention, bold, perhaps, and a little eccentric, insomuch that it has never before been worn, is no sooner adopted by a wealthy *clientèle*, able and willing to pay a high price, than it is imitated, either abroad or in the country, in ribbons cheap, certainly, but inferior and disgraceful copies of the first—at that instant Fashion abandons the article, which must be disposed of at any sacrifice.

The wholesale dealer who buys the ribbons is obliged to calculate thus :—A third for his own profit, a third for the profit of the retail dealer, and the last third, perhaps, for losses. As a result, he does not pay the manufacturer the price that his invention is really worth, and he obliges the first purchasers to pay a price so high that he necessarily restricts their number. It is not only at Saint-Etienne that this deplorable result is produced ; for the greater part of French products are imitated also by plagiarists, the consumer pays very dearly for any beautiful and novel merchandise, and the manufacturer does not receive a sum proportionate to the actual selling price to the public. Elbeuf, Mühlhausen, and

[1] Among the ribbon manufacturers who have contributed to maintain the reputation of Saint-Etienne, we ought to mention the names of Messrs. Peyret-Gerin, Larcher, Philip, Preynat and Rosier, Chapelon and Dauphin, Gemier and Frecon.

all the towns that produce what are termed novelties, are in the same predicament—manufacturing patterns that are speedily imitated by the whole world. It is in industry especially that we can say with pride :—"France is rich enough to pay for her glory ;" but should we not say also, with no less truth, "Often, too, in industry, *glory is money ?*" H. C.

Chemistry applied to the Arts, Metallurgy, Chemical Manufactures, and Allied Subjects.

ABSTRACTS FROM FOREIGN PERIODICALS, TRANSACTIONS OF CHEMICAL SOCIETIES, &c.

§ 1. *Acids, Alkalies, and Salts.*

USE of Sulphuretted Hydrogen.—J. P. COOKE employs for laboratory purposes a solution of sulphuretted hydrogen in water saturated under a pressure of about two atmospheres, and delivered from a syphon somewhat like soda-water. By this means the addition of an inconveniently large quantity of liquid is avoided, as is usually the case when the solution is prepared under the ordinary atmospheric pressure; whilst the waste of materials, and more especially the great fouling of the atmosphere produced when the gas is led through the substance to be treated with sulphuretted hydrogen, are wholly avoided. A special form of apparatus for preparing the bottles charged with sulphuretted hydrogen water under pressure is described. *Chemical News, xxviii.* 64.

Alkalimetry.—CHARPENTIER adds a little freshly precipitated oxide of iron to the alkali to be tested, and then a few drops of sulphocyanide solution ; standard acid is then added, the red colour of sulphocyanide of iron appearing when the alkali is neutralized. *Revue Universelle des Mines, March and April,* 1873.

[The use of sulphocyanide, ferrocyanide, and ferricyanide of iron as indicators in acidimetry and alkalimetry was tried some years ago by us ; they were all found to be inferior in delicacy and accuracy to the vegetable and other colours in ordinary use for that purpose. *Chem. Ed. P. M.*]

Production of Vitriol in Europe.—AIMÉ GIRARD calculates that 800 millions of kilogrammes (800,000 tons) of concentrated oil of vitriol (or weaker acid equivalent thereto) are manufactured yearly in Europe, a quantity which would fill a trench lined with lead, 2 metres deep (6½ ft.), 10 metres wide (32½ ft.), and from 25 to 30 kilometres long (16 to 19 miles). To produce this 600,000 tons of pyrites are used, a quantity which would require at least 60,000 to 80,000 railway trucks to transport. *Revue Scientifique, Sept. 6th,* 1873, *p.* 228.

Preparation of Formic Acid.—LORIN places 1,120 grammes of glycerin in a retort, together with 3,000 of powdered oxalic acid, and applies heat (temperature not stated). Every morning and evening the same quantity of acid is added, the liquid being slightly cooled before the addition is made, in such a manner that the original level is constantly regained after each addition. From 65¾ kilogrammes of oxalic acid there were thus formed 42·14 of formic acid, at 54·6 per cent. real acid, hence representing 23·004 of real acid. The theoretical yield is 23·639 kilogs.; of this difference most was retained by the glycerine, only 0·105 kilogs. being unaccounted for, and hence probably decomposed by a secondary reaction. *Bulletin Soc. Chim. Paris, xx.* 241.

New Apparatus for Extracting Ammonia from Ammoniacal Liquors. — ELWERT and MULLER-PACK patent the use of an improved arrangement possessed of the following advantages :—

1. It gives a white product not subject to alteration by a single distillation.
2. Once charged, the apparatus works continuously without requiring either heating or superintendence.
3. The tubes through which the vapours pass do not become clogged with solid deposit, as they are thoroughly washed out with the liquid introduced in putting in a fresh charge. *Bull. Soc. Chim. Paris, xx.* 329.

Saline Deposits in Indian Lakes.—WALLACE finds that these deposits are of very variable quality :

I. Dulla Khar—Hard crystals, often brown, sometimes greyish.
II. Nummuk Dulla—Roseate crystals.
III. Papree—Non-crystalline deposit.
IV. Bhuoskee—Grey earthy deposit.

	I.	II.	III.	IV.
SOLUBLE IN WATER.				
Anhydrous carbonate of soda	65·26	7·24	35·61	24·64
Excess of carbonic acid	7·35	0·54	3·75	2·25
Carbonate of potassium	0·27	—	0·13	—
Chloride of sodium	0·60	86·66	39·21	20·17
Chloride of magnesium	0·67	trace	trace	trace
Sulphate of calcium	trace	trace	trace	trace
Alumina and phosphate of lime	0·50	0·60	0·50	0·30
INSOLUBLE PART.				
Carbonate of calcium	1·80	1·13	3·95	15·71
Carbonate of magnesium				
Ferric oxide				
Alumina				
Silica				14·45
Organic matter insoluble in water	0·35	0·23	0·80	2·35
Water of crystallization	23·20	3·60	16·05	20·13
	100·00	100·00	100·00	100·00

Egyptian trona is mostly sesquicarbonate of soda ; that from the Indian lakes appears to contain equal quantities of neutral carbonate and sesquicarbonate. *Bulletin Soc. Chim. Paris, xx.* 263.

Artificial Cryolites (double Fluorides of Aluminium and Sodium and Aluminium and Potassium).—The "Société Anonyme de l'Aluminium" patents the following process: Crude hydrofluoric acid containing at most 5 per cent. of acid is re-distilled in a leaden retort so as to separate the sulphuric and hydrofluosilicic acids present in it. The strength is then determined and half the quantity of alumina necessary to saturate it is added ; three equivalents of chloride of sodium are then added for every one of alumina used, whereby artificial cryolite separates in crystals. The double fluoride of aluminium and potassium is obtained in the same way, substituting chloride of potassium for chloride of sodium.

Or the hydrofluoric acid may be half saturated with alumina, half with soda. *Bull. Soc. Chim. Paris, xx.* 330.

Artificial Magnitite.—J. SPILLER points out that several standard works of reference are in error as to the nature of the reaction that takes place in the ordinary process of manufacturing aniline from nitrobenzol by the reducing action of metallic iron.

This is usually stated to give rise to the formation of ferric oxide or "hydrated peroxide of iron." The author points out that the ordinary residual product in this operation is *black*, and can be so far purified by washing and elutriation from the excess of iron usually remaining in admixture as to give a fine black pigment, which appears under the microscope as minute octohedra, and is strongly magnetic. On analysis this is found to consist almost entirely of magnetic oxide of iron, with such impurities as previously existed in the cast-iron. The physical properties of this form of oxide are described, and its analogy to the native varieties of magnetic ore (Cornish and Dannemora) shown by the following analysis of the black substance, dried at 110° C.

Ferric oxide	67·00
Ferrous oxide	30·05
Graphite	1·23
Silica	·78
Phosphoric acid	·62
Sulphur and manganese	traces
	99·68
Metallic iron (total)	70·27

Paper read before the British Association, Bradford.

Preparation of Mercurous Iodide.—LEFORT prepares a salt which he terms "double pyrophosphate of soda and mercurous acetate" by dissolving 60 grammes of pyrophosphate of

soda in 300 of water; after cooling 30 grammes of mercurous acetate are added; this slowly dissolves, forming the new salt, which can be obtained in fine needles two centimetres long. On adding to the above solution, diluted with its own bulk of water, 30 grammes of iodide of potassium dissolved in a litre of water, pure mercurous iodide is precipitated; this can be separated from mercuric iodide, should that be present, by adding a slight excess of the potassium iodide solution, which dissolves the latter but has no effect on the former in that state of dilution; or by hot strong alcohol. *Journal de Pharmacie et de Chimie*, [4] *xvii.* 267.

YVON prepares the salt by heating to 250° in sealed vessels mercury and iodine in the required proportions. Crystals form, red whilst hot, yellow on cooling, and green when illuminated by yellow light; they sublime at 190°, and melt at 290° to a liquid which boils at 310°. On heating highly mercury is set free and an oxyiodide formed crystallizing in clear yellow scales, and alterable by the action of light. *Comptes Rendus, lxxvi.* 1607.

Ashes from Vesuvius.—OSTERLAND and WAGNER find that the "volcanic cinder" of Vesuvius has a composition approximating to that of lava; Rammelsburg deduced the same result from his analyses; but Scacchi thought that it consists of minute particles of the mineral leucite:—

Silica	47·53
Alumina	24·95
Ferric oxide	4·90
Ferrous oxide	3·60
Magnesia	3·33
Lime	12·85
Potash and soda	1·41
Phosphoric acid	0·90
Sulphuric acid	trace.
Sulphur	trace.
	99·47

Berichte der Deut. Chem. Ges. vi. 285.

§ 2.—*Metallurgy.*

Treating Iron Ores and direct Conversion into Steel.—BOISTEL patents a process of reducing iron ores to steel by blowing reducing gases into the molten mass by means of tuyères. Carbonic oxide, hydrocarbons, vapours of petroleum, and other analogous substances may be used. *Bulletin Soc. Chim. Paris, xx.* 324.

Improved Method for Utilizing Burnt Pyrites as Iron Ores.—BOISTEL patents the following process: Sulphur and other impurities are oxidized by heating the powdered mineral in a current of air, oxygen, or steam; or the ore may be fused, whereby sulphur is eliminated through the action of ferric oxide on the residual sulphur. Air or oxygen may be injected into the molten mass, or peroxide of manganese, chlorates, or nitrates incorporated with it, so as to facilitate the oxidation of the sulphur. *Bulletin de la Soc. Chim. Paris, xx.* 325.

[Pyrites containing small percentages of copper is most satisfactorily converted into an iron ore suitable either for direct smelting in conjunction with other ores, or for the "fettling" of puddling furnaces, by the process known as Henderson's, for extracting the copper. Compare "Practical Magazine," Vol. I. p. 378.—*Chem. Ed. P. M.*]

Bowling Iron Works.—J. WILCOCK gives the following analysis of the pig-iron employed at Bowling in the manufacture of the plates, steel, &c. produced there. It appears probable that the manufacture of iron near Bradford dates from the very earliest periods, Roman armour having apparently been made there:—

	No. 1.	No. 2.	No. 3.
Carbon as graphite	3·421	3·155	3·361
Carbon combined	·583	·581	·393
Silicon	1·708	1·646	1·382
Iron	92·070	92·644	92·952
Manganese	1·606	1·472	1·475
Phosphorus	·630	·635	·602
Sulphur	·073	·070	·063
Titanium	trace	trace	trace

Paper read before the British Association, Bradford.

Production of highly Siliciuretted Iron.—S. JORDAN states that a feeble but very hot blast and a deficiency of lime are essential conditions in the formation of "glazed pig," which usually contains from 1·5 to 2·5 per cent. of silicon, but sometimes as much as 7 or 8 per cent. The more silicon is present the brighter is the fractured surface; the fracture is smooth, and not crystalline.

When the following burden was employed, together with a very hot but feeble blast, and a flux containing much silica and alumina, a siliciuretted pig was obtained containing 7·9 per cent. of silicon.

1,250 kilogs. of ore at 30 per cent. metallic iron.
1,000 „ coke.
600 „ flux.

The flux contained:—

Silica	50
Alumina	16
Lime	33
Manganous oxide	1
	100

the proportion of oxygen in the bases being to that in the silica as 17·6 to 26.

The pig thus produced was very liquid and readily filled the moulds, but did not adhere to the sand; its composition was:—

Silicon	7·90
Phosphorus	0·72
Carbon	3·60
Iron	88·78
	100·00

To produce 1,000 kilogrammes of this iron, 2,100 kilogrammes of coke were required. *Comptes Rendus, lxxvi.* 1,086.

Iron and Steel.—W. H. BARLOW states that in 1852 the production of steel in Great Britain was 50,000 tons, whilst at this present time more than 500,000 are annually produced by the Bessemer process alone, Siemens' works at Landore producing upwards of 200,000 tons annually. As an instance of the high value of steel in engineering structures, an open steel girder could now be constructed to take the place of the Britannia Tubular Bridge of a weight little more than one-third that of the present structure, and at a much reduced cost. The method of testing steel rails by the fall of a weight from a height of several feet is open to objection, the bad being thereby destroyed, but many good ones being similarly sacrificed. Sir Joseph Whitworth's process for producing compressed steel of great tenacity and hardness is one of great practical value. A great difficulty in the case of steel for railway structures is, that its use is not sanctioned by the Board of Trade, although numerous regulations exist as to the employment of wrought and cast-iron; the first step towards the attainment of this end is the establishment of a systematic and satisfactory basis for the testing of the steel, so that the strength and toughness of the material can be established beyond doubt. *President's Address, Mechanical Section, British Association Meeting at Bradford.*

Mechanical and Chemical Purification of Pig-Iron.—TESSIE DU MOTAY patents the following method for rendering pig-iron suitable for conversion into malleable iron or steel:—

1. An aerodynamic purifier is used, whereby fusible chemical substances are passed over the molten pig, so as to decarburize or purify it.
2. A special method is employed in the preparation of pig, readily fusible and susceptible of this treatment.
3. A special flux or scoria is used containing lime, fluorspar, oxide of iron and manganese, this flux having special powers in eliminating sulphur, phosphorus, and arsenic from pig-iron.
4. Spiegel is added to the molten mass, whereby steel which yet retains sulphur, phosphorus, or arsenic after complete decarburization, is rendered malleable and capable of welding. *Bulletin Soc. Chim. Paris, xx.* 325.

Composition for Hardening Iron and Improving Steel.—TORRES and CO. patent the use of a powder formed from "burnt silex," pebbles, and hard stones, and mixed with peroxide of manganese, for the purpose of hardening iron (!). The same substance mixed with resin, suet, sal-ammoniac, beeswax, &c., serves to ameliorate burnt steel. *Bulletin Soc. Chim. Paris, xx.* 326.

Improvement in Iron and Steel Manufacture.—BODMER patents the injection into the molten mass of metals, of carbon or various purifying agents. *Bulletin Soc. Chim. Paris, xx.* 326.

Manufacture of Iron and Steel.—WARNER effects purification by the injection of certain chemical agents, such as hydrochloric acid, chlorine, ammonia, &c. *Bulletin Soc. Chim. Paris, xx.* 324.

Preparation of Steel.—WEBSTER patents the use of gaseous hydrocarbons, coal gas (more or less mixed with air or nitrogen), or carbonic oxide mixed with carbonic acid, to acierate superficially iron exposed to the action of the gases, the depth of the steel coating produced varying with the time of exposure, &c.

After being employed for acierating soft iron, the gases can be used for the refining of pig-iron by being injected into the molten substance. *Bull. Soc. Chim. Paris, xx.* 327.

Non-Oxidizable Steel.—LEVALLOIS patents the preparation of steels prepared by melting together the following mixtures :—

	No. 1.
Soft iron . . .	93·0
Tungsten . . .	6·5
Nickel . . .	0·5
	100·0

	No. 2.
Soft iron . . .	95·0
Tungsten . . .	4·5
Nickel . . .	0·5
	100·0

	No. 3.
Soft iron . . .	97·0
Tungsten . . .	2·5
Nickel . . .	0·5
	100·0

Bull. Soc. Chim. Paris, xx. 328.

Use of Electricity for the Manufacture and Purification of Metals.—FORQUIGNON considers that very different results should be obtained by electrolysing melted masses from those obtained by the humid plan, and patents a process whereby precious metals may be separated, and by means of which iron and steel can be directly obtained from pig-iron by electrolysing the molten substances. *Bull. Soc. Chim. Paris, xx.* 327.

[Attempts have been made in England to obtain a better class of iron by the application of electricity to the blast-furnaces, &c., in which the metal is prepared ; but hitherto the process seems to have met with but little practical success, whilst in any case its cost must preclude its adoption to any great extent.—*Chem. Ed. P. M.*]

Ancient Bronze.—E. REICHARDT gives the following analysis of a sample of bronze found near Danzig, and constituting fragments of a ring or other ornament :—

Specific gravity . . .	7·12
Tin	5·591
Silver	trace
Iron	0·363
Lead	0·041
Zinc	1·388
Copper	92·638
	100·021

The author has also collected for comparison the following analyses previously published :—

A. Bronze rings from Gallic sepulchral tumuli (Kopp).
B. Bronze from the bone caves of Périgord (Terreil).
C. Celtic bronze armlets from Aboyne (Church).
D. Bronze statue found at Brescia (Arnaudes).
E. Bronze from Messer, Siberia (Struve).
F. Celtic arrow heads (Olivier).

	A.		B.
Copper . .	89·71	84·76	85·98
Tin . .	7·78	13·31	12·64
Zinc . .	—	—	0·51
Lead . .	1·29	1·80	1·09
Iron . .	0·52	trace	trace
Silver . .	—	—	—

	C.		D.
Copper . .	86·49	88·19	80·70
Tin . .	6·76	3·64	9·44
Zinc . .	1·44	9·13	1·92
Lead . .	4·41	—	7·68
Silver . .	—	—	—
Iron . .	—	—	—

	E.		F.
Copper . .	99·0	88·67	70·30
Tin . .	0·32	10·10	24·53
Zinc . .	—	—	—
Lead . .	—	—	5·20
Silver . .	—	—	—
Iron . .	0·34	0·28	—

It thus appears that there are great differences in the composition of antique bronze even among different specimens found at the same place, the quantities of tin and of lead varying greatly. *Arch. Pharm.* [3] *ii.* 516.

Extraction of Zinc from Lead.—BECK patents an apparatus whereby the zinc is eliquated ; that which remains is separated by heating until the zinc is volatilized. *Bull. Soc. Chim. Paris, xx.* 326.

On the Method of Making Gold Assays, and of stating the Results thereof. — The committee appointed for the purpose of examining this question report as follows :—

The committee first instituted a series of experiments with a view to ascertain to what extent the weight of pieces of pure gold and of alloys synthetically prepared are affected by submitting them to the process of assaying, and consequently how far the results of assay operations are trustworthy. The results of these experiments show that the maximum error is only 1-100th per cent. of the original weight of the assay piece, and consequently that the result obtained by assaying gold represents the composition of the portion of metal under examination to the 1-10,000th part, a fact which will doubtless appear remarkable to all who are accustomed to the ordinary methods of quantitative analysis.

Although it is possible to attain this high degree of accuracy, it is nevertheless well known that a comparison of the assay reports of the different assayers as to the composition of the same ingot often discloses discrepancies of 5-10,000th parts.

Thus, portions of metal from nineteen gold ingots were assayed by the Mint assayer and were then sent to five assayers, each of whom furnished an independent report. Two assayers alone agreed as to the value in each of fifteen ingots ; in three ingots three assayers were in accordance, while in one instance all the assay reports differed ; and viewing the reports generally, the discrepancies varied from 4-10,000th parts to one part of fine gold in 1,000 of the alloy, or an average deviation of 6-10,000th parts.

These small variations assume serious proportions when they affect the value of large quantities of bullion ; for instance, the value of gold coined in the Mint during the past year was £15,200,000, and a persistent error in the assay reports of only 1-10,000th part would have been attended with a gain or loss to the department of no less than £1,500.

The method of gold assaying practised in the Mint has been deliberately adopted by all assayers with certain slight variations of manipulation, which have not as yet been minutely examined, as the committee consider that when widely divergent results are obtained, the gold employed by one or other of the assayers is impure, and that either the amount of impurity has not been ascertained with accuracy, or that it altogether escapes detection. Hence, when the weight of the "cornet" is compared with the initial weight, the portion of metal operated upon appears to indicate the presence of an amount of gold which is in excess of the true amount of precious metal present in the alloy.

The committee obtained specimens of gold from different sources, and tested them side by side with gold prepared in accordance with the directions of the Lords Commissioners of her Majesty's Treasury, by the chemist of the Mint, for use as a standard trial plate in testing the coinage.

Great care was taken in the preparation of this gold, eighty ounces of which were precipitated from no less than a hundred gallons of chloride of gold. The experiments already made have shown that it is very pure ; hence the committee propose to adopt it as the basis of a new series of comparisons. *British Association Reports, Bradford.*

Machine for Sifting and Washing Jewellers' Cinders, &c.—HAMEROUX patents a machine for powdering lumps of material containing precious metals, sifting, and washing the particles thus produced. It is specially intended for jewellers, but can also be used for chemical products. *Bull. Soc. Chim. Paris, xx.* 329.

Tellurium Ore. — J. B. HANNAY describes a mineral occurring in conjunction with arsenical iron pyrites, which contains a considerable amount of tellurium, having the following

percentage compositions, agreeing with the formula $Te_2 As_2 S_7$:—

Tellurium	40·71
Arsenic	23·61
Sulphur	35·81
	100·13

Attempts to prepare this substance artificially from sulphur, arsenic, and tellurium, or from the sulphides of arsenic and tellurium, proved abortive. *Journal of the Chemical Society, xi.* 989.

Preparation of Tellurium.—The Nagyag ores (Transylvania) are treated with hydrochloric acid, first dilute, then concentrated and hot, in order to remove various impurities, especially arsenic and antimony; they are then washed, and warmed with aqua regia; the solution thus obtained is evaporated to drive off nitric acid, and the gold present is precipitated by protosulphate of iron; the filtrate is then treated with zinc or sulphurous acid, whereby the tellurium is thrown down; or the tellurium and gold may be precipitated together from the original solution, and then separated by nitric acid, which dissolves the former. The portion insoluble in aqua regia thus obtained contains silver (as chloride), lead (as chloride and sulphate), antimony (as oxychloride), together with quartz, &c.; to extract the silver, the finer portions are sifted out, and treated with zinc, whereby the metals are reduced; the silver is then dissolved by boiling concentrated sulphuric acid. *Berichte der Deut. Chem. Ges. vi.* 552.

§ 3. *Dyeing, Calico Printing, Bleaching, and allied subjects.*

Violet Derivatives of Methyl-Aniline.—A. W. HOFMANN states that the first attempts to produce colours from aniline alcohol radical derivatives are due to Em. Kopp, who found that the further the substitution of alcohol radicals was pushed, the more the resulting tint differed from red, approaching more and more towards blue. Shortly after, Lauth obtained a violet of great richness, but of little solidity, by the oxidation of methyl-aniline. After Hofmann's discovery of the true composition of rosaniline, and of the fact that the chief product of the action of aniline on rosaniline was a triphenylated derivative, the idea became general that new tints might be obtained by acting not on the original aniline, but on the first-formed derivative, rosaniline, by agents which would effect this substitution; and success attended many attempts of this nature. The high price of iodine, however, rendered the use of the alcohol iodides, *e. g.* methyl-iodide, ethyl-iodide, &c. too costly an operation; hence attempts were made to employ other alcohol derivatives instead, such as methyl-chloride. Bardy succeeded in obtaining methyl-aniline in a cheap way by the action of *nascent* methyl-chloride on aniline, the method adopted being to treat under pressure to 280°—300° a mixture of hydrochloride of aniline and methylic alcohol.

It is well known that to procure rosaniline, pure aniline is unnecessary, in fact undesirable, the presence of a considerable quantity of toluidine in the aniline used being indispensable to the obtaining of a good dyestuff; it therefore appeared not improbable that to procure violet dyes a mixture of methyl-aniline and methyl-toluidine might be essential. It was found, however, that the purer the aniline originally used, the better the violet produced. This, however, might be due to the conversion of aniline into toluidine during the process by the reaction observed by Hofmann and Martius; on the other hand, direct experiment has shown that pure aniline is capable of yielding a fine violet under circumstances when no toluidine is present, and consequently when the latter base takes no part whatever in the reaction. In order to decide whether the violet colouring matters obtainable by the methylation of rosaniline are identical with those produced by the oxidation of dimethyl aniline (*i. e.* whether it is possible to substitute for the expensive process of acting on rosaniline by alcohol radical iodides, the cheaper process of methylating aniline by methyl-chloride, either as such or *in statu nascendi*, and then oxidizing the product as aniline is oxidized to form rosaniline), the author has made a number of experiments and very careful observations, from which it results that *the products of each process are the same.*

The action of methyl-iodide on rosaniline can give rise to three substances in proportions varying with the conditions of the experiment, these three bodies being those indicated by the following formulæ:—

A. Iodomethylate, $C_{20}H_{16}(CH_3)_3N_3,CH_3I$.
B. Di-iodomethylate, $C_{20}H_{16}(CH_3)_3N_3,2CH_3I$.
C. Tri-iodomethylate, $C_{20}H_{16}(CH_3)_3N_3,3CH_3I$.

Of these the first is violet and readily soluble; the second is green, and the third is violet, being distinguished by its sparing solubility and its tendency to crystallize. Now, by the oxidation of methyl-aniline, it might be expected that a related body might be produced, the hydrate of methyl-rosaniline,

$$C_{20}H_{19}(CH_3)N_3,H_2O.$$

Whilst by the oxidation of dimethyl-aniline, it is probable that the methylate corresponding to the compound A above mentioned would result, viz.

$$C_{20}H_{16}(CH_3)_3N_3,CH_3,OH.$$

Hence the oxidation of methyl-aniline could not be expected to yield a dye of similar character to that formed by the action of methyl-iodide on rosaniline, whilst from the oxidation of dimethyl-aniline it is probable that a dye of that character would be formed. Now on oxidizing dimethyl-aniline, either with sulphate of copper and potassium chlorate or by nitrate of copper and common salt, the chloromethylate of trimethyl-rosaniline,

$$C_{20}H_{16}(CH_3)_3N_3,CH_3Cl,$$

(*i.e.* the chloromethylate corresponding to compound A above mentioned), is found to result; and from this the methylate,

$$C_{20}H_{16}(CH_3)_3N_3,CH_3,OH,$$

and thence the iodomethylate,

$$C_{20}H_{16}(CH_3)_3N_3,CH_3I,$$

have been obtained, identical with those formed by the action of methyl-iodide on rosaniline.

To effect the oxidation of dimethyl-aniline, the following formulæ may be employed:—

Dimethyl-aniline	10 parts.
Chlorate of potassium .	1 „
Sulphate of copper .	2 „
Fine sand . . .	100 „

The whole is heated on the water bath for several days, whereby water and aniline are evolved. The residue is dissolved in boiling water, or better, alcohol, and purified by the ordinary processes.

Or instead:—

Dimethyl-aniline . .	10 parts.
Common salt . .	2 „
Nitrate of copper . .	1 „
Water	1 „
Fine sand . . .	100 „

The whole is well mixed, and after an hour 2 parts of glacial acetic acid are added and well mixed in. After two or three hours the mass is made into cakes and dried for two days at a temperature not exceeding 50°. The mass is then digested with a solution of sulphide of sodium of 1·162 specific gravity, 1 part of liver of sulphur being used for every 10 parts of dried cake, and then is treated six or eight times with cold water, and finally with boiling water. From the aqueous solution of dye stuff thus resulting, the colour is precipitated by the addition of common salt.

Besides the methylate and iodo-methylate, other derivatives of the chloro-methylate of trimethyl-rosaniline have been studied, especially the *methyl picrate*, and the corresponding *leuco-derivative;* and finally, the products by the further action of methyl-iodide on the iodo-methylate (*i. e.* the bodies B and C above mentioned) have been prepared. In every instance, perfect agreement in all respects was found between the substances thus resulting from the oxidation of dimethyl-aniline and the products formerly studied obtained by the same reactions from the action of methyl-iodide on rosaniline as starting point.

The tri-iodo-methylate (body C) may be obtained in quantity by heating together in an enamelled autoclave for three to four hours, at a temperature not exceeding 115°, the following mixture:—

Rosaniline . . .	10 parts.
Methyl-iodide . .	12 „
Methylic alcohol . .	20 „

Methylic ether is formed, and escapes as a vapour when the autoclave is opened. The tri-iodo-methylate is deposited in crystals on cooling. Care must be taken not to heat too long, else *octo-methylated leucaniline,*

$$C_{60}H_{16}(CH_3)_8N_3,3CH_3I,$$

is formed, instead of the required tri-iodo-methylate of trimethyl rosaniline.

The di-iodo-methylate (*iodine green*) thus obtained from dimethyl-aniline, being identical with that formed by the direct action of methyl-iodide on rosaniline, it results that the green dye as well as the violet ones can thus be produced. By heating the monoiodo-methylate (3 parts) with methyl-iodide (2 parts)

to 115°-120° for four hours, iodine green is formed in quantity, together with the sparingly soluble tri-iodo-methylate. *Berichte der Deut. Chem. Ges. vi.* 352.

Aniline Green for Straw, &c.—The straw is placed in boiling water for ten minutes or a quarter of an hour, and is then plunged for half an hour into a cleared solution of 30 grammes bleaching powder and 30 crystallized soda in 10 litres of water, and next into water soured with hydrochloric acid for five minutes (40 grammes to 10 litres); finally, the straw is passed through an iodine green bath at 40°, a little picric acid being added, and the bath being cleared before use. *Reimann's Färberzeitung*, 1872, *No.* 46.

Printing Aniline Colours on Cotton.—50 grammes of gelatine are dissolved in a litre of water; potassium dichromate is then added till the colour becomes a pale yellow; the aniline colour is then added, and thickened with starch, dextrine, or gum. After printing, the pieces are exposed to light for some hours, whereby the gelatine is rendered insoluble, and thus the design is fixed. *Moniteur de la Teinture, April* 5, 1873.

Nicholson Blue.—BRAUN finds that this blue (alkali blue) can be used where acid baths are required for further washing if a little zinc sulphate be added to the acid bath. If *pure* zinc sulphate be used, no change is produced in the shade developed. In the same way, many other aniline colours exhibit much more stability if sulphate of zinc be added to the dye bath. *Reimann's Färberzeitung*, 1873, *No.* 9.

Alkali Blue for Cotton.—Five kilogrammes of cotton are mordanted with 192 grammes tannin, 16 of tin salts, and 16 of copper sulphate, being allowed to remain in the bath for one hour. After draining, the goods are passed into a warm bath of 32 grammes alkali blue; after remaining in this bath for an hour, the goods are again drained and passed through a cold acid bath of very dilute sulphuric acid. *Reimann's Färberzeitung*, 1873, *No.* 7.

Blue Dye for Cottons, free from Indigo.—Twenty-five kilogs. of cotton are boiled with soda, rinsed, and dried; 2 kilogs. of starch are boiled with 13 litres of water, and after cooling 300 grammes chlorate of potash, 600 chloride of copper, and 1,200 of hydrochlorate of aniline are added, with constant stirring (or 600 grammes chloride of copper and 4,500 of aniline may be used for the same weight of goods); through 9 litres of this mixture are passed 1 kilog. of cotton five or six times: ½ litre of mixture is then added, and a second kilog. of cotton passed through, and so on till all is used up. The cotton is then oxidized by heating in a stove to 30° Reaumur (37°·5 C.), steam being injected from time to time to maintain the temperature. The starch is then removed by rinsing in a bath of water to which 3 kilogs. of malt are added; after a day has elapsed the goods are rinsed and passed through a weak bath of sulphuric acid, and then through a soda bath at 2° or 3° B. A blue-black tint is thus developed; to obtain a better blue the aniline and copper chloride (or hydrochlorate of aniline), and chlorate of potash, may be diminished by one-third. *Reimann's Färberzeitung*, 1873, *Nos.* 1 *and* 2.

Indigo-Dyeing.—SCALA patents the following process, by which brighter and more brilliant blues may be obtained on woollens, cottons, &c., with considerable economy of colouring matter.

Woollen Goods.—"Rocou" is added to water at 20°-30°, in quantity proportionate to the depth of shade required. The temperature is raised to 70°-80°, and the goods immersed for ten minutes. After washing they are placed in another bath, to which 3-4 kilogs. of blue liquid litmus and half a glass of sulphuric acid are added per 50 kilogs. of wool. After working for ten minutes at 40°, the temperature is raised to boiling for fifteen minutes. The goods are then washed and placed in the indigo vat. Addition of a little fresh colour renders the bath fit for use over again.

For army blue, marine blue, &c., which will stand the usual tests, annatto is used, with the addition of 1·5 to 2 kilogs. of madder; or 2 to 3 kilogs. of sandal-wood, cachou, or black terra japonica, for every 50 kilogs. of material. The cachou should be separately boiled and clarified.

For cottons and thread goods the same process is applicable, greater or lesser quantities being used according to the shade required.

The annatto is prepared by dissolving in warm water, sifting, adding 4 kilogs. of potash to every 5 of annatto and 90 litres of water; the whole is stirred up, boiled three minutes, and allowed to cool. *Bull. Soc. Chim. Paris, xx.* 334.

Fine Lilac for "Mouchoirs de Balbec" and other Goods.—SAUVAGE patents the use of the following process, whereby madder colours are rendered unnecessary for the production of the particular shade; cotton of coarse quality can also be used.

First, a bottom of indigo is given; the goods are washed and passed into a gall bath, and thence into a chromate of potash bath, 7 kilogs. of the first, and 1·5 of the second substance being employed per 50 kilogs. of cotton. Next they are boiled with 7·5 kilogs. of sandal-wood, and 3·5 kilogs. of Hayti Campeachy wood; in this bath they are steeped and boiled for an hour each operation, and then removed; 4 kilogs. of alum and 4 of hydrochloric acid are then added to the bath, and the goods replaced and worked about. They are then washed and toned in a bath of Campeachy wood with 3 kilogs. of alum, being allowed to oxidize therein for twelve hours. Finally the goods are thoroughly washed and softened in oil.

The old process required six weeks for dyeing, whereas the above method only requires one week. *Bull. Soc. Chim. Paris, xx.* 328.

Valuation of Anthracene.—PAUL and COWNLEY propose to substitute oxidation of anthracene to anthraquinone by chromic acid dissolved in glacial acetic acid, for the present unsatisfactory process of treatment with alcohol or bisulphide of carbon; 178 parts of good anthracene yield 208 of anthraquinone, melting at 276° C. *Paper read before the British Association, Bradford.*

Purpurin.—The purpurin of madder can be used for black, red, rose, and lilac on cotton, wool, or silk; the goods are mordanted, dyed, and soaped at 50° or 60° to brighten the colour and develope the whites; 1 to 2 grammes dye a square metre of cotton goods. For wool, the goods are boiled with tin salts or cream of tartar, then passed into the dye vat for half an hour. Tannin may be added to the bath with advantage.

For printing, 20 grammes of purpurin and 45 of soda are dissolved in boiling water, starch added to thicken, and the whole made up to 1 litre; after printing the goods are steamed.

For silk, alumina acetate and chalk mordant are used; after dyeing the goods are passed through gum tragacanth at 200°, and printed with a mixture of 30 grammes purpurin, 12 of soda crystals, and 200 of roasted starch. After printing, the goods are steamed and soaped at 62°; fine colours are thus obtained. *Reimann's Färberzeitung*, 1873, *No.* 2.

Dyeing Feathers.—The feathers should be soaked in solution of carbonate of ammonium or sodium, whereby they are rendered less liable to break or bend; after being dyed they should be dried in a current of warm air.

Feathers may be dyed black in the following baths.

No. 1.
50 litres water.
1 lb. ignited sodium carbonate.

No. 2.
Ferric nitrate at 70° B.

No. 3.
Logwood 2 lbs.
Quercitrine 2 lbs.

Half a pound of feathers is digested in bath No. 1 at 30°; the feathers are then washed with warm water, and soaked in bath No. 2. After another washing they are boiled in No. 3, until of a deep black colour; they are then dipped in an emulsion formed by agitating oil and potassium carbonate together, and dried by gently swinging them in warm air.

Feathers may be dyed brown by first treating them with catechu and then with potassium chromate; they can be dyed directly with aniline colours, and can be bronzed by painting with aniline violet dissolved in alcohol at 90 per cent. *Dingler's Polytech. Journal, ccviii.* 318.

Ammoniacal Soap for Cleansing Wool.—ASHART employs putrefied urine as a cheap source of ammonia for making ammoniacal soaps; the ammoniacal urine is neutralized by an acid or a metallic salt, and a potash or soda soap added; a coagulum is thus obtained consisting of ammoniacal soap. Though insoluble or nearly so in water, this readily dissolves in alkaline fluids, a 1 or 2 per cent. solution of carbonate of soda being the best solvent; this solution is used for wool scouring, and allows a whiteness to be attained, and gives a suppleness, superior to that given by ordinary soaps. *Moniteur de la Teinture, April 20th*, 1873.

[Probably the advantages spoken of here as possessed by the ammoniacal soap are due to the use of a *cold* washing agent, the employment of hot liquors, especially alkaline ones, greatly damaging the wool and injuring its fibre. *Vide* "Practical Magazine," Vol. I. p. 52.—*Chem. Ed. P. M.*]

Use of Bisulphide of Carbon for removing Grease from Wool.—JEAN states that whilst no injurious action whatever is exerted on wool by cold bisulphide of carbon, which readily removes all greasy matter, it is, nevertheless, difficult to get rid of the last traces of bisulphide by a current of cold air, and moreover, much solvent is thereby lost; on the other hand, if hot air or steam be used, the wool loses much of its elasticity, and acquires a yellowish hue which cannot be removed; this is apparently due to the action of the heated bisulphide on the fibre. Hence the use of this substance is not to be preferred to that of benzene. *Moniteur de la Teinture, xvii.* 142.

[The use of fusel oil by Toepler's patent gets rid of the difficulty of removing the last traces of solvent without heat, fusel oil being sufficiently soluble in water to allow of the residual oil being entirely washed out by that agent; apart from the action of bisulphide of carbon on wool fibre, the mere fact of applying heat to wool injures it. *Compare* "Practical Magazine," Vol. I. p. 52.—*Chem. Ed. P. M.*]

Preparation of Dextrine.—The following mixture is heated on the water bath until the starch reaction is no longer given with iodine:

Starch . . .	500 parts
Cold distilled water	1,500 „
Oxalic acid . .	8 „

Chalk is then added to neutralize; after subsidence the liquor is evaporated on the water bath to a paste; it can then be dried in a warm place; 220 parts of pure dextrine are thus obtained. *Journal de Pharmacie et de Chim.* [4] *xviii.* 39.

§ 4. *Food and Sanitary Matters.*

Sea-water for Bread-making.—Bread made with sea-water, so as to possess the right amount of saltness, is stated to have capital hygienic qualities; it keeps for a week in a fresh state, and has been tried on board a sailing-vessel between Havre and San Francisco. During the whole voyage no illness occurred with a crew of twenty-five, together with a hundred and sixty passengers. It will probably prove efficacious in cases of dyspepsia, phthisis, scrofula, and goître. *Les Mondes, xxxi.* 724.

Refining of Sugar.—POSSOZ patents the treatment of sugar residues with lime and the carbonation and precipitation of the dissolved lime by acid phosphate of lime, phosphate of alumina, phosphate or carbonate of ammonia, &c. *Bull. Soc. Chim. Paris, xx.* 333.

Composition of Oat Flour.—DUJARDIN, BEAUMETZ, and HARDY give the following analysis:—

Water	8·7
Fatty matter	7·5
Starch	64·0
Azotized substances . . .	11·7
Mineral matter	1·5
Cellulose and undetermined . .	7·6
	100·0
Nitrogen	2·0

From a comparison of this analysis with others of wheat, rice, rye, &c, it appears that oats are more nutritious, and hence that the extensive use made of this grain in England (more especially Scotland) as a food is justified. By feeding children on oats and milk (porridge?) the authors have verified its fattening power by direct weighing. *Union Médicale, April,* 1873.

Adulteration of Coffee.—J. MULLER states that the presence of starchy substances, such as roasted corn, in commercial ground coffee, can readily be detected by shaking up the powdered coffee with dilute caustic potash solution, filtration, and dilution with much water. If starchy substances be present, the liquid gives the well-known blue coloration with iodine solution. *Dingler's Polytech. Journal, ccviii.* 80.

Coloration of Sausages by Aniline.—E. REICHARDT points out that the use of rosaniline (fuchsine) to communicate to pale-coloured and inferior sausage-meat the red tint characteristic of good meat is becoming of frequent occurrence. In the case of genuine flesh the tint is derived from the colouring matters of the blood. These are not dissolved by either alcohol or ether; if, however, sausages coloured by fuchsine are digested with alcohol or ether, the colouring matter is dissolved out, communicating to the solvent the characteristic tint of fuchsine solution. The author has estimated the fuchsine present in some specimens to amount to as much as 0·005 grammes per kilogramme of sausage.

Independently of the circumstance that the dyeing of sausage-meat in this way is a fraud on the purchaser, inferior (and sometimes objectionable or even deleterious) ingredients being substituted for good food, the practice is extremely objectionable, firstly on account of the probably injurious effects arising from the frequent introduction of aniline compounds into the system, and secondly on account of the extremely frequent presence of arsenic in fuchsine. Even although the arsenic is introduced into the sausages in extremely small quantities, yet its occurrence in food of any kind is always a thing to be avoided whenever practicable. *Arch. Pharm.* [3] *ii.* 514.

Grass-root Sugar.—HERMANN MÜLLER concludes from his experiments that the root of the "quick-grass" contains no other kind of sugar than ordinary fruit sugar, neither cane sugar nor dextrose being present, although previous preliminary experiments led him to a contrary opinion. Lactic acid does not exist in the root, and when present in the medicinal extract has been formed by some fermentative process during the manufacture of the extract. The dry root contains from $2\frac{1}{2}$ to $3\frac{1}{3}$ per cent. of fruit sugar. *Arch. Pharm.* [3] *ii.* 500.

Triticin.—HERMANN MÜLLER gives directions for preparing this peculiar gum-like substance from the roots of the quick-grass, the process consisting mainly in making a weak alcoholic extract of the root, freeing from several impurities by treating with lead acetate, animal charcoal, &c., and separating the gum from sugar and other products by precipitating the gum from the aqueous solution of the mixture by addition of alcohol. The dry root contains 6 or 8 per cent. of its weight of triticin, but only one-third or one-fourth of this is obtainable in the pure state, owing to losses in the various processes for extraction and purification, the process occupying, moreover, some twelve to fourteen days. *Arch. Pharm.* [3] *ii.* 507.

Influence of Atmospheric Pressure on Fermentation.—H. T. BROWN finds that a diminution in the atmospheric pressure retards in a remarkable manner the alcoholic fermentation; the retardation, however, does not appear to be in any way proportionate to the pressure diminution; the amount of carbonic acid formed, on the other hand, becomes greater when the pressure is less, this being probably due to a secondary action, which is facilitated by diminution of pressure, viz. the conversion of sugar into succinic acid, carbonic acid, and glycerine. It does not appear that the slower progress of the fermentation is due to rupture of the cell-walls of the yeast plant. Acetic acid is formed in much greater quantity when the fermentation takes place under greatly reduced pressure than at the ordinary pressure of the atmosphere. It is noticeable that by the conversion of sugar solution into acetic acid there is an increase in the total volume of liquid, whilst the reverse holds in the case of the production of alcohol from sugar; consequently the lesser production of alcohol and the larger formation of acetic acid under diminished pressure are phenomena in accordance with Sorby's law, viz. that "pressure weakens or strengthens chemical affinity, according as it acts against or in favour of the change in volume." *Journal of the Chemical Society, xi.* 973.

Natural Waters.—E. REICHARDT gives the following tables, indicating in parts per 100,000 of water the average amount of the principal solid ingredients from various kinds of rock formations:—

	Granite.	Clay slate.	Bunter Sandstein.
Total solids . .	2·4	8·80	From 12·5 to 22·5
Organic matter . .	1·57	From traces to 0·73	1·38
Nitric acid . . .	—	From traces to 0·05	From traces to 0·98
Chlorine . . .	0·33	From traces to 0·25	0·42
Sulphuric acid . .	0·39	From traces to 0·24	0·88
Magnesia . . .	0·25	0·65	4·80
Lime	0·97	2·25	7·30
Hardness . .	1·27	3·15	13·96

	Muschel-kalk.	Dolomitic Muschelkalk.	Gypsum.
Total solids . . .	32·5	41·8	236·5
Organic matter . .	0·90	0·53	trace
Nitric acid . . .	0·02	0·23	trace
Chlorine	0·37	trace	1·61
Sulphuric acid . .	1·37	From traces to 3·4	110·82
Magnesia . . .	2·90	6·50	12·25
Lime	12·90	14·00	76·60
Hardness . .	16·95	23·10	92·75

The author states that all river water is condemned by the Vienna Water Supply Commission, on the ground that its purity is always open to suspicion. *J. Pr. Chem.* [2] *vii.* 26.

Impregnation of Water by Copper.—E. REICHARDT points out that natural waters take up copper from pipes of that material, just as lead or iron is taken up from leaden or iron service pipes. The quantity of copper taken up diminishes with the lapse of time, but even after many years is considerable and even dangerous; thus, a sample of water drawn through copper service pipes in 1859 contained 7·2 parts of copper per million; the same water in 1872 contained only 0·8 parts per million; but even the latter sample gave, on treatment with soap, a perceptible amount of green copper-soap. *Arch. Pharm.* [3] *ii.* 513.

Ozonized Water.—RAMMELSBURG states that the substances sold as ozonized water, owe their action to the presence of chlorine. *Berichte Deut. Chem. Ge. vi.* 603.

BEHRENS and JACOBSON, on the other hand, find that ozonized water is only a dilute solution of hypochlorous acid. *Vierteljahrschrift für Pharmacie, xxii.* 230.

Bitter-almond Water.—A. KOSTER proposes to examine this pharmaceutical preparation by Liebig's method (consisting of titration with a silver solution of known strength), so as to ensure that the substance is exactly the right strength. The German pharmacopœia requires that 1 part of hydrocyanic acid should be contained in 1,000 of almond water; if a standard silver solution, containing 3·148 grammes of silver nitrate per litre be used, the almond water will be of exactly the right strength when its own bulk of silver solution is required to produce a permanent precipitate (caustic soda and a little chloride of sodium being also added). If too strong, the amount of water to be added to dilute the almond water to the right point is known by simply adding the silver solution from a graduated vessel until a permanent precipitate is formed, and reading of the total volume used; then, if 10 of water require 15 of silver, half its bulk of plain water must be added to the almond water to dilute it to the right strength. *Arch. Pharm.* [3] *ii.* 510.

Juniper Berries.—E. DONATH gives the following analysis:—

Water	29·44
Essential oil	0·91
Formic acid	1·86
Acetic acid	0·94
Malic acid	0·21
Oxalic acid	—
Fat resembling wax . . .	0·64
Green resin	8·46
Hard brown resin . . .	1·29
Juniperin	0·37
Pectin	0·73
Protein substances . . .	4·45
Sugar	29·65
Cellulose	15·83
Mineral constituents . . .	2·33
	97·11

Dingler's Polytech. Journal, ccviii. 300.

Utilization of Sewage.—The committee appointed for the purpose of examining this question, report that their investigations lead them to the following conclusions:—

1. All conservancy plans, including midden heap and cesspool systems, dry ash and earth closets, pail closets, &c. are quite incompetent as solutions of the general question of the removal of the refuse matters of a population; they only deal with a small part of the liquid manure; towns which resort to one of them require to be sewered, and the sewage requires to be purified. The manure produced in all cases (except in that of pails or tubs where no extraneous materials are added) is poor and will only bear the cost of carriage to a short distance, taking into consideration the cost of collection; that produced by the dry earth system, even after the earth has been used three times over, is merely a good garden mould. Moreover, these plans all violate one of the most important of sanitary laws, which is that all refuse matters which are liable to become injurious to health should be removed instantly and dealt with afterwards. With all these plans it is an obvious advantage on the score of economy to keep the refuse about the premises as long as possible, and the consequently necessary use of disinfectants of various sorts, proves that these systems all depend upon a fallacious principle. They should therefore be discouraged as much as possible, and only resorted to as temporary expedients, with small populations, or in very exceptional instances.

2. The water-carriage system, on the other hand, is based upon a sound principle, viz., that of removing all the refuse matters at once and in the cheapest possible manner, by gravitation, and it therefore ought to be resorted to in all but the most exceptional cases. The opinion of the committee is that all sewers should be made of impervious materials, and that separate drains to dry the subsoil should be constructed where necessary. The freest possible ventilation of sewers, house-drains, and soil pipes, in order to prevent accumulations of foul air, is also essential. With regard to the utilization of sewage, the committee has come to the conclusion that the precipitation processes examined by it are all necessarily incompetent to effect more than a separation of a small part of the valuable ingredients of sewage, and hence that only a partial purification is effected by them. Some of them, however, may be useful as methods of effecting a more rapid and complete separation of the sewage sludge.

The upward filtration process only effects clarification of the sewage, and is, therefore, not a complete solution of the question at issue.

Weare's charcoal filtration process, as carried on at Stoke-upon-Trent workhouse, does not give satisfactory results, the effluent water being in effect weak sewage; an opportunity will, however, soon be given for an examination of this process in a modified form on a much larger scale at Bradford, under more favourable conditions. Intermittent downward filtration through soil has been shown at Merthyr Tydvil to afford means of purifying the sewage under favourable conditions, but it can only be said to be a partial method of utilization, as the investigations made by the committee show that the effluent water contains as much nitrogen as the original sewage, but mainly as nitric acid, instead of ammonia and organic nitrogen; there can be no doubt that the process will prove useful as an adjunct to irrigation, or where a sufficient amount of land for irrigation cannot conveniently be got.

By properly conducted sewage irrigation a solution is afforded to the question of sewage utilization; as already stated, a precipitation process, or some clarifying process, may be found useful in conjunction therewith; in all instances it is essential that the land should be well underdrained, and that the sewage should all pass through the soil and not merely over it, otherwise it will only occasionally be satisfactorily purified. The catchwater or "supersaturation" principle is indefensible on either agricultural, chemical, or sanitary principles; an irrigation farm should therefore carry out intermittent downward filtration on a large scale, so that the sewage may be always thoroughly purified, whilst at the same time the maximum utilization is effected.

3. Although all kinds of crops can be grown by the aid of sewage, yet cattle food, with occasional corn crops, must be the staple; analysis shows that the manurial constituents of the sewage accumulate in the soil, rendering it much richer at the end of a period of application of sewage than it was at the commencement. Cattle should be fed on the farm so as to increase the production of milk and meat; for these purposes the system of farming must be specialized, and capital concentrated. The absence of these necessary conditions has hitherto proved a great barrier to the satisfactory practical solution of the sewage question.

No ill effects have been traced in the health of persons living around sewage farms, even when badly conducted; nor is there any proof whatever that vegetables grown thereon are in any way inferior to vegetables grown with ordinary manure; on the contrary, there is plenty of evidence that such vegetables are perfectly suitable for the food both of man and beast, whilst the milk given by cows fed on sewage grass is perfectly wholesome; in one instance (Merthyr Tydvil) the plentiful use of milk from cattle fed on sewage grass, not only caused no increase in the infant mortality, but even apparently diminished the infant death-rate, this falling from 48 to 52 per cent. of the total deaths to 39 per cent.; whilst so far from diarrhœa having been made more prevalent by the use of sewage cabbages, "last year the Registrar-General called attention to the fact that diarrhœa was less prevalent in Merthyr than in any place in England and

Wales ;" and he expressed his belief in "the perfect salubrity of the vegetable food so grown."

With regard to the assumption which has been made that entozoic disease would be propagated by irrigation, all the evidence that the country has been able to collect, and more especially the positive facts obtained by experiments, are against such an idea, and the committee is consequently of opinion that such disease will certainly not be more readily propagated by sewage irrigation than by the use of human refuse as manure in any other way, and probably less so if the precaution be taken of not allowing the animals to graze, but of always having the grass cut and carried to them. *British Association Reports, Bradford Meeting.*

Detection of Arsenic in Papers.—HAGER impregnates the paper with a solution of nitre, dries, and burns it on a plate; the ashes are boiled with dilute caustic potash, the liquor filtered, and sulphuric acid added and permanganate solution until no more is decolorized; finally the cold filtered liquid is treated in a flask with zinc and sulphuric acid, two papers being placed on the neck, one being impregnated with lead acetate, the other with silver nitrate; unless sulphuretted hydrogen be formed, the first is not blackened; whilst the second is blackened if arseniuretted hydrogen be evolved, *i.e.* if arsenic be present in the paper. *Chemisches Centralblatt, iv.* 285.

Apparatus for Respiration and Lighting in Explosive or Irrespirable Atmospheres.—DENAYROUZE patents the following three pieces of apparatus:—

1. Regulator for supplying air to workman or lamp.
2. Special lamp for burning without danger in explosive atmospheres.
3. Reservoir constructed on the same principles as the regulator, and furnishing a supply of air carried with him by the workman.

An arrangement for filtering dust, &c., from air previous to respiration, and capable of being carried about on the shoulder whilst in use, is described. Certain noxious gases can be absorbed in this apparatus when required. *Bulletin Soc. Chim. Paris, xx.* 332.

Action of Alcohol on Warm-Blooded Animals.—BINZ details a number of experiments which show that one important effect of alcohol upon the human frame is to diminish the temperature to the extent of from three to five degrees Fahrenheit; this effect is produced by the action of the alcohol on the heart, causing more blood to circulate through the vessels of the skin, which are thus dilated. The alleged heating of the organism from alcohol does not exist. The subjective impression is, at least partially, the consequence of irritation of the nerves of the stomach and of the enlargement of the vessels of the skin. When given in small quantities the thermometer shows no extraordinary increase or decrease of the temperature of the blood; moderate doses, which need not lead to drunkenness, show a distinct decrease of about half-an-hour's duration or more; and inebriating quantities evince a still more decided lowering, lasting several hours. The decrease after moderate doses takes place to the greatest extent in warm-blooded animals which have not for some time previously had alcohol administered to them. The author injected under the skin of rabbits or dogs about a cubic centimeter of ichor, which in a short time produced death, but when alcohol diluted with water was simultaneously administered either by the stomach or the skin, the animal was quite lively and took kindly to its food. Alcohol is more than a simple stimulant: it is a strong antipyretic and an equally powerful antiseptic. *Paper read before the British Association, Bradford.*

§ 5. *Fuel, Heating, Illumination, Light, Photography, &c.*

Nantyglo Coal Cutting Machine.—CLAPP'S machine consists of a frame in which are worked nine parallel horizontal drills all driven at the same rate by a pinion at their inner ends; this frame is capable of being fed forwards by a pair of screws at the two sides of the frame, and can be inclined at any angle by raising or lowering the side supports. The machine will hole 35 square yards of face per hour (as much as 50 in the case of soft coal), including the moving of the machines; the slot cut is 2½ in. wide and about 3 ft. deep. As yet the machine has not been in use, owing to prejudice, and difficulties amongst the workmen. *Paper read before the British Association, Bradford.*

Distribution of Coal in China.—BARON VON RICHTOFEN stated, that he had been engaged in travelling through most of the provinces of the empire of China from the year 1868 to 1872, the main object in view being the geographical and geological features of the country. He had availed himself of all the information the natives could afford of the occurrence of coal in different localities, and had thus been enabled to visit most of the coal-fields of importance. By the frequent occurrence of fossils, he was able to establish the existence and wide extent in numerous localities of the Devonian, Carboniferous, and Permian formations; in fact, China is almost entirely made up of the older strata. The Carboniferous formation is perhaps the one most widely spread over the country, and wherever it occurs coal beds are present, as is also the case in many of the Permian and Triassic districts. Owing to the softness of the superimposed strata, the coal measures have undergone a great amount of denudation, and a determination of the extent to which this has gone on, will afford a measure of the mineral wealth in the different geological districts of the country. The denudation in some provinces, such as Shansi, Hoonan, Yunnan, and Kensu, has been just sufficient to bring the coal beds nearly to the surface, thus rendering easy of access an amount of coal unrivalled in any other country. Coal basins of the extent of from 30,000 to 100,000 square miles have been discovered. In some places the finest anthracite is 7*d.* per ton at the pit's mouth, the miners merely quarrying the coal at the out-crops of the seams, which are sometimes 30 feet in thickness. *Paper read before the British Association, Bradford.*

Search for Coal in the Wealden District.—HENRY WILLETT gave a summary of the results achieved up to the present time. The boring was commenced at the time of the last meeting of the British Association at Brighton, its object being to explore the rocks underlying the Weald of Sussex. A bore of 6¼ inches diameter was first contemplated, but one of 9 inches diameter is now employed. The bore has now reached a depth of 300 feet, and the engineer has contracted to increase it to a depth of 418 feet, at the cost of only £1 per foot. Of the 300 feet of strata already passed through, about seventy were previously known, but the remaining 230 are new to science; fifty feet of this consists of valuable beds of gypsum. The author has designed a novel form of drill, which possesses the following advantages:—1st, It cuts only the circumference; 2nd, it makes better progress; 3rd, the central core is left intact; 4th, the tool not unfrequently extracts the core itself. The gypsum was extracted by this means, and it is believed that no such cores have been brought to the surface from similar depths in this country. *Brit. Assoc. Meeting at Bradford.*

Combustible Bricks.—CORY patents the manufacture of brick-shaped combustible masses obtained by mixing the powdered combustible matters with hydraulic cement (Roman or Portland), pozzolana or other plastic clay, and silicate of soda or potash. The materials are used in these proportions:—

Silicate at specific gravity 3 (*sic*) . .	2 to 4 parts.
Cementing ingredients	4 „ 5 „
Combustible matter	100 „

The whole is mixed in a mill and shaped in a specially-devised machine. *Bulletin Soc. Chim. Paris, xx.* 335.

Use of Air mixed with Steam for Locomotives.—R. HEATON states that by injecting air (heated by the waste heat) at about 650° F. into the boiler, incrustation and priming are avoided, and there is less liability to explosion, and less fuel is required. The results obtained in practice by this process are highly satisfactory, a saving of fuel to the extent of something like 20 per cent being effected. *Paper read before the British Association, Bradford.*

Prevention of Incrustation in Steam Boilers.—J. WAUGH gives the following notes on this subject:—

The evil effects of scale are attributable to the fact that it is relatively a non-conductor of heat; a scale of one-sixteenth of an inch thick requires 15 per cent.; when it is a quarter of an inch thick, 60 per cent.; and at half an inch thick, 150 per cent. more fuel. Attempts to remove impurities by means of chemicals tend to corrode the plates. Another difficulty is found in the great difference in the quality and quantity of the impurities in the various waters used for steam, thus rendering it impossible to find any substance universally applicable. Caustic soda is the most effectual preventive when used in quantities proportionate to the percentage of impurities, and the plates are not deteriorated in any way by its use. Austin has recommended the use of glycerine, which forms a soluble compound with the principal impurities. When the lime salts are present to such an extent as to be no longer soluble in the glycerine present, they are deposited in the form of a gela-

tinous sediment which does not adhere to the boiler surface. The proportions recommended to be used are one pound of glycerine to every three hundred or four hundred pounds of coal burnt. It is to be feared, however, that the cost of glycerine will not allow of its general adoption. Supposing crude glycerine in quantities could be supplied at 4*d.* per lb., a firm using five hundred tons of coal per week would expend, at the lowest rate, £46 13*s.* per week, or about £2,425 per annum. In water free from sulphate of lime excellent results have been obtained from the use of old boilers as precipitators. The feed water is passed in direct from the supply, and then raised to boiling-point only by the introduction of steam. The carbonates of lime and magnesia, along with impurities held in suspension, are allowed to settle, when the water is allowed to pass into the pressure-boiler to be converted into steam. The incrustation does not adhere to the plates, and can readily be blown out or otherwise removed. *The use of pure water is the only effectual remedy for the evils of boiler incrustation.* Boilers fed with pure water are able to supply the cylinders with dry steam of the best quality, free from sediment or grit, a prolific source of expense—cylinders, glands, and pistons requiring to be bored in consequence. Pure water also prevents priming. The importance of the subject cannot be over-rated, looking at it from an economical point of view, as it involves the shortened length of life of the boiler, and the extra amount of fuel daily consumed. *Paper read before the British Association, Bradford.*

Purification of Tallow.—The tallow is melted and pressed through a linen filter while hot; it is then boiled with water, strained off, and allowed to cool; when solid, it is washed with water, freed from moisture by pressure, melted, and run into earthenware vessels provided with tightly-fitting covers. When well preserved from the air, tallow thus purified will keep a long time without acquiring a bad odour or becoming rancid. *Dingler's Polytech. Journal, ccvii.* 516.

Melting Fats.—FORTOUL patents the use of a vessel, furnished with a diaphragm and heated by steam, for the purpose of melting suet, &c. The molten mass is isolated from that yet remaining solid by the diaphragm, whilst a peculiar consistency is gained in the melted fat by passing a galvanic current through the apparatus (!). No chemicals are thus necessary whilst "rendering" suet; from 90 to 92 per cent. of molten fatty matter is obtainable, whilst from the solid residue 4-5 per cent. more can be obtained by treatment with sulphuric acid. *Bulletin Soc. Chim. Paris, xx.* 236.

Scenting Fatty Matters.—PIVER patents the use of a rotary apparatus for holding the "bugadiers" or vessels in which fatty matters are placed in contact with flowers, &c., so as to absorb their scent; also a special warming apparatus. *Bulletin Soc. Chim. Paris, xx.* 238.

Essential Oil of Pastinaca Sativa.—RENESSE states that this oil has a density of 0·8672 at 17·5°, and distils for the most part at 244° to 245°; the essential constituent is butyrate of octyl, from which may be obtained normal butyric acid, and normal octyl alcohol, identical with that from the *Heracleum spondylium.* From this alcohol octylamine and dioctylamine have been prepared. *Annalen der Chem. und Pharm. clxvi.* 80.

Distillation at High Temperature.—PIVER patents the use of high pressure vapour for the distillation of scented substances out of fats, &c., impregnated therewith, and also certain alterations and improvements in the vessels used for the purpose. *Bulletin Soc. Chim. Paris, xx.* 238.

A New Form of Rutherford's Minimum Thermometer.—JAMES HICKS has constructed a thermometer the design of which is to obtain increased sensitiveness by extension of the surface of the "bulb" exposed to the air. This is attained by making the bulb in the form of a hollow cylinder with double sides and open ends, the spirit being a film of any desired degree of thinness between the two glass sides. The performance of the new thermometer compares well with that of the ordinary spherical bulb. An additional advantage is claimed for the new instrument—viz. constancy of zero, since the change in capacity of the bulb, caused by contraction of the glass, is greatly reduced, owing to contraction of the internal cylinder occurring simultaneously with that of the outer cylinder, leaving the capacity nearly constant.

The ordinary minimum alcoholic thermometer frequently reads lower when old than when freshly made, the difference being sometimes as much as four degrees (Glaisher); the converse is usually the case with mercurial thermometers. *British Association, Bradford.*

Explosives.—ROUX and SARRALL have determined the heat disengaged and the quantity of gas produced by the combustion of various kinds of powder by determining the pressure developed on explosion of a known weight in a special apparatus consisting essentially of a small iron cannon 22 millimetres internal diameter and 3 decimetres in length, with the muzzle of which is connected a peculiar kind of manometer. Inflammation is brought about, not by means of a touch-hole, but by insulated electric wires passing through the breech.

The following numerical results have been obtained :—

Kinds of powder.	Calories disengaged by combustion of a kilogramme of powder.	Weight of gases evolved per kilogramme of powder.	Reduced volume of gases per kilogramme of powder.
Fine hunting powder . .	807·3		234 litres.
Cannon „ . .	752·9		261 „
Shooting powder, called "B."	730·8		280 „
Poudre du Commerce Extérieur	694·2		281 „
Ordinary blasting powder .	570·2		307 „
Gun-cotton. . . .	1056·3	0·853	720 „
Vosges dynamite, at 75 per cent.	1290·0	0·600	455 „
Picrate of potash . .	787·0	0·740	576 „
Mixture of 55 parts picrate of potash and 45 parts saltpetre.	916·3	0·485	334 „
Mixture of equal parts picrate and chlorate of potash .	1180·2	0·466	329 „

In the case of the first five of these substances the following results are also calculated :—

Name of powder.	Temperature of combustion in degrees Centigrade.	Atmospheres pressure exerted by permanent gases produced.	Maximum work produced by production of gas, in metre tons.
Fine hunting powder .	4,654	3,989	373
Cannon „ .	4,360	4,168	349
Shooting „ "B."	4,231	4,339	339
Poudre du Commerce Extérieur . . .	4,042	4,160	324
Ordinary blasting powder	3,372	3,792	270

Les Mondes, xxxi. 754.

Automatic Air Carburizer.—JÜNGLING patents an apparatus consisting of a ventilator or aspirator, whereby the air is forced into the gas generator, which consists of a vertical cylinder, into which air and petroleum are introduced through one orifice whilst the carburized air escapes by another aperture; the hydrocarbon is introduced in quantity so proportioned to the evaporation that it never accumulates in the liquid state in the generator. The light thus produced is very brilliant, and can be readily used in places distant from gas works, for railway carriages, &c. *Bull. Soc. Chim. Paris, xx.* 331.

Apparatus for Carburizing Air.—PARODY patents a special apparatus whereby the air to be carburized is brought in a gentle, regular stream to a vessel where it meets with capillary streams of the hydrocarbons employed, so as to impregnate it with their vapours. *Bulletin Soc. Chim. Paris, xx.* 335.

Fireworks.—E. A. LAMARRE patents the following compositions for coloured signal lights, the speciality claimed being the use of linseed oil in place of resin or turpentine :—

White Light.

Potassium chlorate . .	100 parts
Antimony sulphide . .	10 „
Boiled linseed oil . . .	15 „

Red Light.

Potassium chlorate . .	50 „
Strontium nitrate . . .	50 „
Wood charcoal . . .	5 „

Boiled linseed oil, as much as is necessary to knead the whole together.

Green Light.

Potassium chlorate . .	50 parts
Barium nitrate . . .	50 „
Wood charcoal . . .	5 „

Linseed oil, as much as is necessary to knead the whole together.

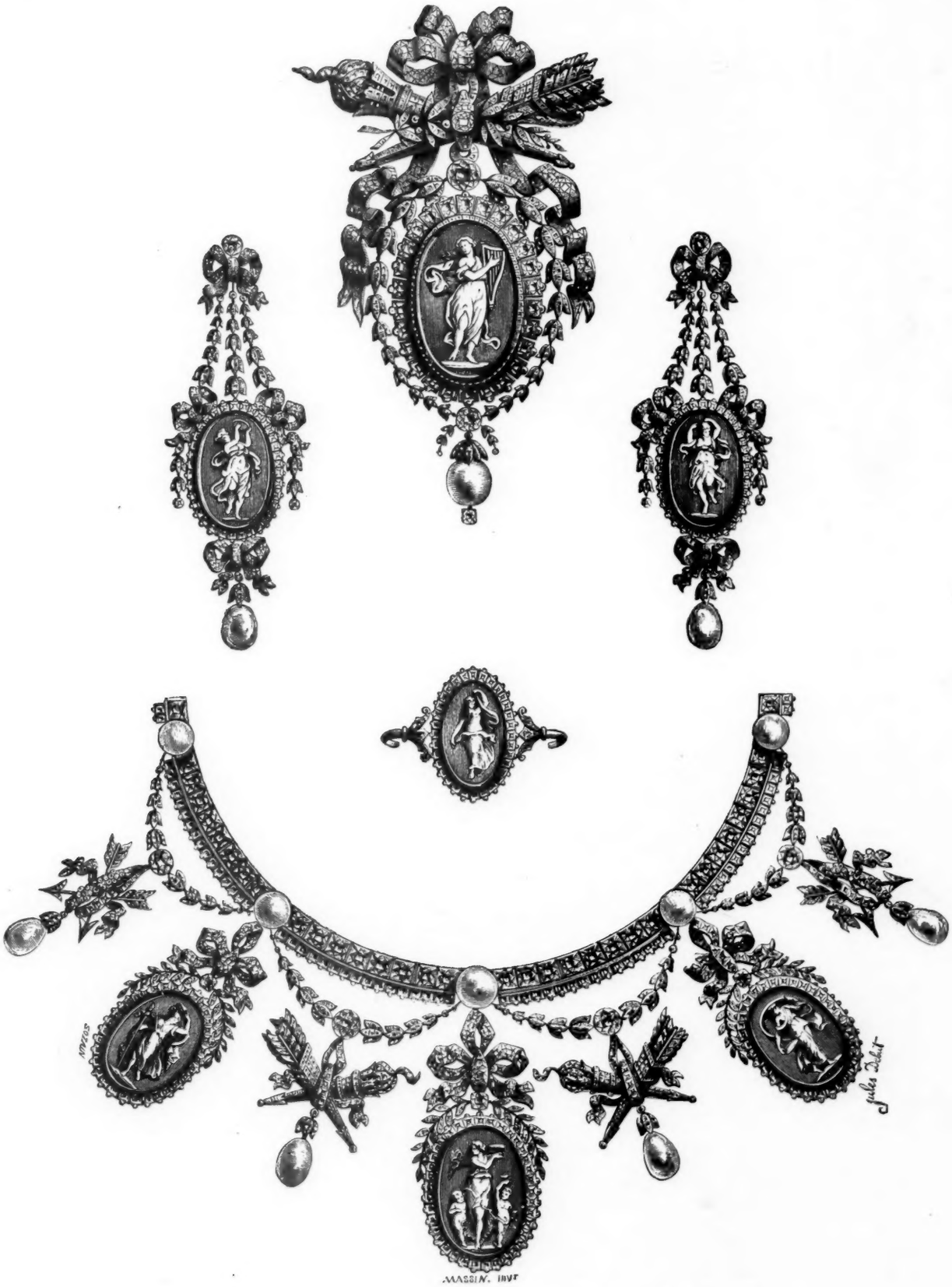
Dingler's Polytech. Journal, ccviii. 78.

Residuary Aberration in Microscopes and Telescopes.—G. W. ROYSTON-PIGOTT describes a method of experimenting whereby any residuary error, whether of achromatism, spherical aberration, or mechanical construction, are demonstrated with a most keen severity; this method consists in the examination of the image of the sun formed by a prism-heliostat furnished with suitable lenses; diffraction rings of great brilliancy and beauty are thus formed, which by their regularity and appearance afford the means of detecting residual errors even when very minute. One of the results arrived at is that *achromatism and aplanatism in the best constructed glasses are altogether incongruous*, whilst very many glasses are found to be over-corrected spherically. Residual spherical aberration is the great difficulty in the way of determining and defining minute organic particles, such as the molecules of physiological cells, blood discs, mucous globules, and in the discrimination of various forms of disease; the finest definition is obtained by stopping out the most obnoxious rays, either by using a mono-chromatic ray which suits the aplanatism, or by employing bluish green or blue glass to pale the red rays, it being possible for glasses to be aplanatic to one ray but not to another of different refrangibility. In telescopes these residual errors are apt to impair the accuracy of delicate operations, such as the determination of contacts (*e.g.* on the transit of Venus). *Proceedings of the Royal Society, xxi.* 426.

MR. RUSKIN ON THE STUDY OF INDUSTRIAL ART.[1]

IT is to be remembered that the giving of prizes can only be justified on the ground of their being the reward of superior diligence and more obedient attention to the directions of the teacher. They must never be supposed, because practically they never can become, indications of superior genius; unless in so far as genius is likely to be diligent and obedient, beyond the strength and temper of the dull. But it so frequently happens that the stimulus of vanity, acting on minds of inferior calibre, produces for a time an industry surpassing the tranquil and self-possessed exertion of real power, that it may be questioned whether the custom of bestowing prizes at all may not ultimately cease in our higher schools of art, unless in the form of substantial assistance given to deserving students who stand in need of it; a kind of prize, the claim to which, in its nature, would depend more on accidental circumstances, and generally good conduct, than on genius. But, without any reference to the opinions of others, and without any chance of partiality in your own, there is one test by which you can all determine the rate of your real progress. Examine, after every period of renewed industry, how far you have enlarged your faculty of admiration. Consider how much more you can see to reverence in the work of masters, and how much more to love in the work of nature. This is the only constant and infallible test of progress. That you wonder more at the work of great men, and that you care more for natural objects. You have often been told by your teachers to expect this last result; but I fear that the tendency of modern thought is to reject the idea of that essential difference in rank between one intellect and another, of which increasing reverence is the wise acknowledgment. You may, at least in early years, test accurately your power of doing anything in the least rightly, by your increasing conviction that you never will be able to do it as well as it has been done by others. That is a lesson, I repeat, which differs much, I fear, from the one you are commonly taught. The vulgar and incomparably false saying of Macaulay's, that the intellectual giants of one age become the intellectual pigmies of the next, has been the text of too many sermons lately preached to you. You think you are going to do better things—each of you—than Titian and Phidias; write better than Virgil; think more wisely than Solomon. My good young people, this is the foolishest, quite pre-eminently—perhaps almost the harmfullest—notion that could possibly be put into your empty little eggshells of heads. There is not one in a million of you who can ever be great in anything. To be greater than the greatest that have been is permitted, perhaps, to no man in Europe in the course of two or three centuries. But because you cannot be Handel and Mozart, is it any reason why you should not learn to sing "God save the Queen" properly, when you have a mind to? Because a girl cannot be *prima donna* in the Italian Opera, is it any reason that she should not learn to play a jig for her brothers and sisters in good time, or a soft little tune for her tired mother, or that she should not sing to please herself, among the dew, on a May morning? Believe me, joy, humility, and usefulness always go together; as insolence with misery, and these both with destructiveness. You may learn with proud teachers how to throw down the Vendôme Column, and burn the Louvre, but never how to lay so much as one touch of safe colour, or one layer of steady stone; and if, indeed, there be among you a youth of true genius, be assured that he will distinguish himself first, not by petulance or by disdain, but by discerning firmly what to admire and whom to obey. It will, I hope, be the result of the interest lately awakened in art through our provinces, to enable each town of importance to obtain, in permanent possession, a few—and it is desirable there should be no more than a few—examples of consummate and masterful art, an engraving or two by Dürer, a single portrait by Reynolds, a 15th century Florentine drawing, a 13th century French piece of painted glass, and the like; and that, in every town occupied in a given manufacture, examples of unquestionable excellence in that manufacture should be made easily accessible in its civic museum. I must ask you, however, to observe very carefully that I use the word manufacture in its literal and proper sense. It means the making of things by the hand. It does not mean the making of them by machinery. And, while I plead with you for a true humility in rivalship with the works of others, I plead with you also for a just pride in what you really can honestly do yourself. You must neither think your work the best ever done by man, nor, on the other hand, think that the tongs and poker can do better, and that, although you are wiser than Solomon, all this wisdom of yours can be outshone by a shovelful of coke. Let me take, for instance, the manufacture of lace, for which, I believe, your neighbouring town of Nottingham enjoys renown. There is still some distinction between machine-made and hand-made lace. I will suppose that distinction so far done away with, that, a pattern once invented, you can spin lace as fast as you now do thread. Everybody then might wear, not only lace collars, but lace gowns. Do you think they would be more comfortable in them than they are now in plain stuff; or that, when everybody could wear them, anybody would be proud of wearing them? A spider may, perhaps, be rationally proud of his own cobweb, even though all the fields in the morning are covered with the like, for he made it himself; but suppose a machine spun it for him? Suppose all the gossamer were Nottingham made, would a sensible spider be either prouder or happier, think you? A sensible spider! You cannot, perhaps, imagine such a creature. Yet, surely, a spider is clever enough for his own ends. You think him an insensible spider, only because he cannot understand yours, and is apt to impede yours. Well, be assured of this, sense in human creatures is shown also, not by cleverness in promoting their own ends and interests, but by quickness in understanding other people's ends and interests, and by putting our own work and keeping our own wishes in harmony with theirs. But I return to my point, of cheapness. You do not think that it would be convenient, or even creditable, for women to wash the doorsteps or dish the dinners in lace gowns? Nay, even for the most ladylike occupations—reading, or writing, or playing with her children—do you think a lace gown, or even a lace collar, so great an advantage or dignity to a woman? If you think of it, you will find the whole value of lace, as a possession, depends on the fact of its having a beauty which has been the reward of industry and attention. That the thing itself is a prize—a thing which everybody cannot have. That it proves, by the look of it, the ability of its maker; that it proves, by the rarity of it, the dignity of its wearer—either that she has been so industrious as to save money, which can buy, say, a piece of jewellery, of gold tissue, or of fine lace—or else, that she is a noble person, to whom her neighbours concede, as an honour, the privilege of wearing finer dress than they. If they all choose to have lace too—if it ceases to be a prize—it becomes, does it not, only a cobweb? The real good of a piece of lace, then, you will find, is that it should show, first, that the designer of it had a pretty fancy; next, that the maker of it had fine fingers; lastly, that the wearer of it has worthiness, or dignity enough to obtain what is difficult to obtain, and common sense

[1] Read (in Mr. Ruskin's absence) by the Duke of St. Albans, at the Mansfield Town Hall, on the occasion of prizes being presented to the successful Students of the Night Art Class connected with the Mechanics' Institute.



GEMS OF INDUSTRIAL ART.—PARURE (LOUIS XVI.), BY BOUCHERON.

enough not to wear it on all occasions. I limit myself, in what farther I have to say, to the question of the manufacture—nay, of one requisite in the manufacture—that which I have just called a pretty fancy. What do you suppose I mean by a pretty fancy? Do you think that, by learning to draw, and looking at flowers, you will ever get the ability to design a piece of lace beautifully? By no means. If that were so, everybody would soon learn to draw, everybody would design lace prettily, and then, nobody would be paid for designing it. To some extent, that will, indeed, be the result of modern endeavour to teach design. But against all such endeavours, mother-wit, in the end, will hold her own. But anybody who has this mother-wit may make the exercise of it more pleasant to themselves, and more useful to other people, by learning to draw. An Indian worker in gold, or a Scandinavian worker in iron, or an old French worker in thread, could produce, indeed, beautiful designs out of nothing but groups of knots and spirals; but you, when you are rightly educated, may render your knots and spirals infinitely more interesting by making them suggestive of natural forms, and rich in elements of true knowledge. You know, for instance, the pattern which for centuries has been the basis of ornament in Indian shawls—the bulging leaf ending in a spiral. The Indian produces beautiful designs with nothing but that spiral. You cannot better his powers of design, but you may make them more civil and useful by adding knowledge of nature to invention. Suppose you learn to draw rightly, and therefore to know correctly the spirals of springing ferns—not that you may give ugly names to all the species of them—but that you may understand the grace and vitality of every hour of their existence. Suppose you have sense and cleverness enough to translate the essential character of this beauty into forms expressible by simple lines—therefore, expressible by thread—you might then have a series of fern-patterns which would each contain points of distinctive interest and beauty, and of scientific truth, and yet be variable by fancy, with quite as much ease as the meaningless Indian one. Similarly there is no form of leaf, of flower, or of insect which might not become suggestive to you, and expressible in terms of manufacture, so as to be interesting and useful to others. Only do not think that this kind of study will ever "pay" in the vulgar sense. It will make you wiser and happier. But do you suppose that it is the law of God, or nature, that people shall be paid in money for becoming wiser and happier? They are so, by that law, for honest work; and as all honest work makes people wiser and happier, they are, indeed, in some sort, paid in money for becoming wise. But if you seek wisdom only that you may get money, believe me, you are exactly on the most foolish of all fool's errands. "She is more precious than rubies;" but do you think that is only because she will help you to buy rubies? "All the things thou canst desire are not to be compared to her." Do you think that is only because she will enable you to get all the things you desire? She is offered to you as a blessing in herself. She is the reward of kindness, of modesty, of industry. She is the prize of prizes, and—alike in poverty or in riches—the strength of your life now, and the earnest of whatever life is to come.

ON FUEL.[1]

By C. Wm. Siemens, D.C.L., F.R.S.

IN accepting the invitation of the council of the British Association to deliver an address to the operative classes of this great industrial district, I felt that I was undertaking no easy task. Having to speak on behalf of the Association, and in the presence of many of its most distinguished members, I am bound to treat my subject scientifically, but I have to bear in mind at the same time that I am addressing myself to men unquestionably of good intelligence, but without that scientific training which has almost created a language of its own.

It is no consolation for me to think, that those who have taken a similar task upon themselves in former years have admirably succeeded in divesting highly scientific subjects of the formalism in which they are habitually clothed. The very names of these men—Tyndall, Huxley, Miller, Lubbock, and Spottiswoode—are such as to preclude in me all idea of rivalry, but I hope to profit by their example, and to remember that truth must always be simple, and that it is only where knowledge is imperfect that scientific formulæ must take the place of plain statements.

[1] A lecture delivered to the operative classes at Bradford, on behalf of the British Association.

The subject matter of my discourse is "Fuel," a matter with which every one of us has become familiarized from his infancy, but which nevertheless is but little understood even by those who are most largely interested in its applications; it involves considerations of the highest *à priori* interest, both from a scientific and a practical point of view.

I purpose to arrange my subject under five principal heads:—

1. What is fuel?
2. Whence is fuel derived?
3. How should fuel be used?
4. The coal question of the day.
5. Wherein consists the fuel of the sun?

What is Fuel?

Some of you may have already said within yourselves that it is but wasted time to enlarge upon such a theme, since all know that fuel is coal drawn from the earth from deposits with which this country especially has been bountifully supplied; why disturb our plain understanding by scientific definitions which will neither reduce the cost of coal nor make it last longer on our domestic hearth?

Yet I must claim your patience for a little, lest, if we do not first agree upon the essential nature of fuel, we may afterwards be at variance in discussing its origin and its uses, the latter at any rate being of practical interest, and a subject worthy of your most attentive consideration.

Fuel, then, in the ordinary acceptation of the term, is carbonaceous matter, which may be in the solid, the liquid, or in the gaseous condition, and which, in combining with oxygen, gives rise to the phenomenon of heat. Commonly speaking, this development of heat is accompanied by flame, because the substance produced in combustion is gaseous. In burning coal, for instance, on a fire-grate, the oxygen of the atmosphere enters into combination with the solid carbon of the coal and produces carbonic acid, a gas which enters the atmosphere, of which it forms a necessary constituent, since without it the growth of trees and other plants would be impossible. But combustion is not necessarily accompanied by flame, or even by a display of intense heat. The metal magnesium burns with a great display of light and heat, but without flame, because the product of combustion is not a gas but a solid, viz. oxide of magnesia. Again, metallic iron, if in a finely divided state, ignites when exposed to the atmosphere, giving rise to the phenomena of heat and light without flame, because the result of combustion is iron oxide or rust; but the same iron, if presented to the atmosphere—more especially to a damp atmosphere—in a solid condition, does not ignite, but is nevertheless gradually converted into metallic oxide or rust as before.

Here, then, we have combination without the phenomena either of flame or light; but by careful experiment we should find that heat is nevertheless produced, and that the amount of heat so produced precisely equals that obtained more rapidly in exposing spongy iron to the action of oxygen. Only in the latter case the heat is developed by slow degrees, and is dispersed as soon as produced, whereas in the former the rate of production exceeds the rate of dispersion, and heat therefore accumulates to the extent of raising the mass to redness. It is evident from these experiments that we have to widen our conception, and call fuel "*any substance which is capable of entering into combination with another substance, and in so doing gives rise to the phenomenon of heat.*"

In thus defining fuel, it might appear at first sight that we should find upon our earth a great variety, and an inexhaustible supply of substances that might be ranged under this head; but a closer investigation will soon reveal the fact that its supply is, comparatively speaking, extremely limited.

In looking at the solid crust of the earth, we find it to be composed for the most part of siliceous, calcareous, and magneceous rock; the former, silica, consisting of the metal silicon combined with oxygen, and is therefore not fuel, but rather a burnt substance which has parted with its heat of combustion ages ago; the second, limestone, being carbonate of lime, or the combination of two substances, viz. oxide of calcium and carbonic acid, both of which are essentially products of combustion, the one of the metal calcium, and the other of carbon; and the third, magnesia, being the substance magnesium, which I have just burnt before you, and which, further combined with lime, constitutes dolomite rock, of which the Alps are mainly composed. All the commoner metals, such as iron, zinc, tin, alumina, sodium, &c., we find in nature in an oxidized or burnt condition; and the only metallic substances that have resisted the intense oxidizing action that must have prevailed at one period of the earth's creation are the so-called precious metals, gold, platinum, iridium, and to some extent also silver and copper. Excepting these, coal alone presents itself as carbon and hydrogen in an unoxidized condi-

tion. But what about the oceans of water, which have occasionally been cited as representing a vast store of heat-producing power ready for our use when coal shall be exhausted? Not many months ago, indeed, on the occasion of a water-gas company being formed, statements to this effect could be seen in some of our leading papers. Nothing, however, could be more fallacious. When hydrogen burns, doubtless a great development of heat ensues, but water is already the result of this combustion (which took place upon the globe before the ocean was formed), and the separation of these two substances would take precisely the same amount of heat as was originally produced in their combustion. It will thus be seen that both the solid and fluid constituents of our earth, with the exception of coal, of naphtha (which is a mere modification of coal), and the precious metals, are products of combustion, and therefore the very reverse of fuel. Our earth may indeed be looked upon as "*a ball of cinder, rolling eternally through space*," but happily in company with another celestial body—the sun,—whose glorious beams are the physical cause of everything that moves and lives, or that has the power within itself of imparting life, heat, or motion. The invigorating influence is made perceptible to our senses in the form of heat. But it is fair to ask, what is heat, that it should be capable of coming to us from the sun, and of being treasured up in our fuel deposits both below and on the surface of the earth?

If this inquiry had been put to me thirty years ago, I should have been much perplexed. By reference to books on physical science, I should have learnt that heat was a subtle fluid which, somehow or other, had taken up its residence in the fuel, and which, upon ignition of the latter, was sallying forth either to vanish or to abide elsewhere; but I should not have been able to associate the two ideas of combustion and development of heat by any intelligible principle in nature, or to suggest any process by which it could have been derived from the sun and petrified; or, as the empty phrase ran, rendered latent in the fuel.

It is by the labours of Mayer, Joule, Clausius, Rankin, and other modern physicists, that we are enabled to give to heat its true significance.

Heat, according to the "dynamical theory," is neither more nor less than motion amongst the particles of the substance heated, which motion, when once produced, may be changed in its direction and its nature, and thus be converted into mechanical effect, expressible in foot-pounds, or horse-power. By intensifying this motion among the particles, it is made evident to our visual organ by the emanation of light, which again is neither more nor less than vibratory motion imparted by the ignited substance to the medium separating us from the same. According to this theory, which constitutes one of the most important advances in science of the present century, heat, light, electricity, and chemical action are only different manifestations of "energy of matter," mutually convertible, but as indestructible as matter itself.

Energy exists in two forms, "dynamic" or "kinetic energy," or force manifesting itself to our senses as weight in motion, as sensible heat, or as an active electrical current; and "potential energy," or force in a dormant condition. In illustration of these two forms of energy, I will take the case of lifting a weight, say one pound one foot high. In lifting this weight kinetic, muscular energy, has to be exercised in overcoming the force of gravitation of the earth. The pound weight, when supported at the higher level to which it has been raised, represents potential energy to the amount of one unit or foot-pound. This potential energy may be utilized in imparting motion to mechanism during its descent, whereby a unit amount of "work" is accomplished. A pound of carbon, then, when raised through the space of one foot from the earth, represents, mechanically speaking, a unit quantity of energy; but the same pound of carbon being separated or lifted away from oxygen, to which it has a very powerful attraction, is capable of developing no less than 11,000,000 foot-pounds or unit quantities of energy whenever the bar to their combination, namely, excessive depression of temperature, is removed; in other words, the mechanical energy set free in the combustion of one pound of pure carbon is the same as would be required to raise 11,000,000 pounds weight one foot high, or as would sustain the work which we call a horse-power during five hours thirty-three minutes. We thus arrive at once at the utmost limit of work which we can ever hope to accomplish by the combustion of one pound of carbonaceous matter, and we shall presently see how far we are still removed in our steam-engine practice from this limit of perfection.[1]

[1] In burning 1 lb. of carbon in the presence of free oxygen, carbonic acid is produced and 14,500 units of heat (1 lb. of water raised through 1° Fah.) are liberated. Each unit of heat is convertible (as proved by the deductions of Mayer and the actual measurements of Joule) into 774 units of force or mechanical energy; hence 1 lb. of carbon represents really 14,500 × 774 = 11,223,000 units of potential energy.

The following illustrations will show the convertibility of the different forms of energy. If I let the weight of a hammer descend in rapid succession upon a piece of iron it becomes hot, and on beating a nail thus vigorously and skilfully for a minute it will be red hot. In this case the mechanical force developed in the arm by the combustion of carbonaceous muscular fibre is converted into heat. Again, in rapidly compressing the air in a fine syringe, ignition of a piece of tinder is obtained. Again, in passing an electrical current through the platinum wire, it is directly converted into heat, which is manifested by ignition of the wire; whereas the thermopile gives an illustration of the conversion of heat into electricity. The heat of combustion is the result of the chemical combination of two substances; but does it not follow from this that oxygen is a combustible as well as the carbonaceous substance which goes by the name of fuel? This is, unquestionably, the case, and if our atmosphere was composed of a carbonaceous gas we should have to conduct our oxygen through tubes, and send it out through burners to supply us with light and heat, as will be seen by the experiment in which I burn a jet of atmospheric air in a transparent globe filled with common lighting gas; but we could not exist under such inverted conditions, and may safely strike out oxygen and analogous substances, such as chlorine, from the list of fuels.

We now approach the second part of our inquiry:—

Whence is Fuel Derived?

The rays of the sun represent energy in the form of heat and light, which is communicated to our earth through the transparent medium which must necessarily fill the space between us and our great luminary. If these rays fall upon the growing plant, their effect disappears from direct recognition by our senses, inasmuch as the leaf does not become heated as it would if it were made of iron or dead wood; but we find a chemical result accomplished, viz., carbonic acid gas, which has been absorbed by the leaf of the tree from the atmosphere, is there "dissociated," or separated into its elements, carbon and oxygen, the oxygen being returned to the atmosphere, and the carbon retained to form the solid substance of the tree.

It is thus clearly shown that the sun has to impart 11,000,000 units of energy to the tree for the formation of one pound of carbon in the shape of woody fibre, and that these 11,000,000 units of energy will be simply resuscitated when the wood is burnt, or again combined with oxygen to form carbonic acid.

Fuel, then, is derived through solar energy acting on the surface of our earth.

But what about the stores of mineral fuel, of coal, which we find within its folds? How did they escape the general combustion which, as we have seen, has consumed all other elementary substances? The answer is a simple one. These deposits of mineral fuel are the results of primeval forests, formed in the manner of to-day through the agency of solar rays, and covered over with earthy matter in the many inundations and convulsions of the globe's surface, which must have followed the early solidification of its surface. Thus our deposits of coal may be looked upon as the accumulation of potential energy derived directly from the sun in former ages; or, as George Stephenson, with a sagacity of mind in advance of the science of his day, answered, when asked what was the ultimate cause of motion of his locomotive engine, "that it went by the bottled-up rays of the sun."

It follows from these considerations that the amount of potential energy available for our use is confined to our deposits of coal, which, as appears from the exhaustive inquiries lately made by the Royal Coal Commission, are still large indeed, but by no means inexhaustible, if we bear in mind that our requirement will be ever on the increase, and that the getting of the coal will become from year to year more difficult as we descend to greater depths. To these stores must be reckoned lignite and peat, which, although not coal, are nevertheless the result of solar energy, attributable to a period of the earth's creation subsequent to the formation of the coal beds, but anterior to our own days. These fuels may be made as efficient as coal if properly treated.

In discussing the necessity of using our stores of fuel more economically, I have been met by the observation that we need not be anxious about leaving fuel for our descendants—that the human mind would surely invent some other source of power when coal should be exhausted, and that such a source would probably be discovered in electricity. I heard such a suggestion publicly made only a few weeks back at a meeting of the International Jury at Vienna, and could not refrain from calling attention to the fact that electricity is only another form of energy, that could no more be created by man than heat could, and involved the same recourse to our accumulated stores.

If our stores of coal were to ebb, we should have recourse, no doubt, to the force radiating from the sun from year to year, and from day to day; and it may be as well for us to consider what is the extent of that force, and what our means of gathering and applying it. We have, then, in the first place the accumulation of solar energy upon our earth's surface by the decomposition of carbonic acid in plants, a source which we know by experience suffices for the human requirements in thinly populated countries, where industry has taken only a slight development. Wherever population accumulates, however, the wood of the forest no longer suffices even for domestic requirements, and mineral fuel has to be transported from great distances.

The sun's rays produce, however, other effects besides vegetation, and amongst these, that of evaporation is the most important as a source of available power. By the solar rays, an amount of heat is imparted to our earth that would evaporate yearly a layer of water fourteen feet deep. A considerable proportion of this heat is actually expended in evaporating sea water, producing steam or vapour, which falls back upon the entire surface of both land and sea in the form of rain. The portion which falls upon the elevated land flows back towards the sea in the form of rivers, and in its descent its weight may be utilized to give motion to machinery. Water power, therefore, is also the result of solar energy, and an elevated lake may indeed be looked upon as fuel, in the sense of its being a weight lifted above the sea level through its prior expansion into steam.

This source of power has also been largely resorted to, and might be utilized to a still greater extent in mountainous countries; but it naturally so happens that the great centres of industry are in the plains, where the means of transport are easy, and the total amount of available water-power in such districts is extremely limited.

Another result of solar energy are the winds, which have been utilized for the production of power. This source of power is, indeed, very great in the aggregate, but its application is attended with very great inconvenience. It is proverbial that there is nothing more uncertain than the wind, and when we were dependent upon windmills for the production of flour, it often happened that whole districts were without that necessary element of our daily existence. Ships also, relying upon the wind for their propulsion through the sea, are often becalmed for weeks, and so gradually give preference to steam-power on account of its greater certainty. It has been suggested of late years to utilize the heat of the sun by the accumulation of its rays into a focus by means of gigantic lenses, and to establish steam-boilers in such foci. This would be a most direct utilization of solar energy, but it is a plan which would hardly recommend itself in this country, where the sun is but rarely seen, and which even in a country like Spain would hardly be productive of useful, practical results.

There is one more natural source of energy available for our uses, which is rather cosmical than solar—viz. the tidal wave. This might also be utilized to a very considerable extent in an island country, facing the Atlantic seas, like this, but its utilization on a large scale is connected with great practical difficulty and expenditure, on account of the enormous area of tidal basin that would have to be constructed.

In passing in review these various sources of energy which are still available to us, after we have run through our accumulated capital of potential energy in the shape of coal, it will have struck you that none of them would at all supply the place of our willing and ever-ready slave—the steam-engine; nor would they be applicable to our purposes of locomotion, although means might possibly be invented of storing and carrying potential energy in other forms. But it is not force alone that we require, but heat for smelting our iron and other metals, and the accomplishment of other chemical processes. We also need a large supply for our domestic purposes. It is true that with an abundant supply of mechanical force we could manufacture heat, and thus actually accomplish all our purposes of smelting, cooking, and heating, without the use of any combustible matter; but such conversion would be attended with so much difficulty and expenditure that one cannot conceive human prosperity under such laborious and artificial conditions.

We come now to the question—

How should Fuel be used?

I propose to illustrate this by three examples which are typical of the three great branches of consumption.

a. The production of steam power.
b. The domestic hearth.
c. The metallurgical furnace.

Steam Engine Consumption.—I have represented on a diagram two steam cylinders of the same internal dimensions, the one being what is called a high-pressure steam cylinder, provided with the ordinary slide valve for the admission of steam and its subsequent discharge into the atmosphere, and the other so arranged as to use the steam expansively (being provided with the Corliss variable expansion gear) and working in connection with a condenser. I have also shown two diagrams of the steam pressures at each part of the stroke, assuming in both cases the same initial steam pressure of 60 lbs. per square inch above the atmospheric pressure, and the same load upon the engine. They show that in the latter case the same amount of work is accomplished by filling the cylinder, roughly speaking, up to one-third part of the length, as in the other by filling it entirely. Here we have then an easy and feasible plan of saving two-thirds of the fuel used in working an ordinary high-pressure engine, and yet probably the greater number of the engines now actually at work are of the wasteful type. Nor are the indications of theory in this case (or in any other when properly interpreted) disproved by practice; on the contrary, an ordinary non-expansive non-condensing engine requires commonly a consumption of from 10 to 12 lbs. per horse-power per hour, whereas a good expansive and condensing engine accomplishes the same amount of work with 2 lbs. of coal per hour, the reason for the still greater economy being, that the cylinder of the good engine is properly protected by means of a steam jacket and lagging against loss by condensation within the working cylinder, and that more care is generally bestowed upon the boiler and the parts of the engine, to insure their proper working condition.

A striking illustration of what can be accomplished in a short space of time was brought to light by the Institute of Mechanical Engineers, over which I have at present the honour to preside. In holding their annual general meeting in Liverpool in 1863, they instituted a careful inquiry into the consumption by the best engines in the Atlantic steam service and the result showed that it fell in no case below $4\frac{1}{2}$ lbs. per indicated horse-power per hour. Last year they again assembled with the same object in view in Liverpool, and Mr. Bramwell produced a table showing that the average consumption by seventeen good examples of compound expansive engines did not exceed $2\frac{1}{4}$ lbs. per indicated horse-power per hour. Mr. E. A. Cowper has proved a consumption not exceeding $1\frac{1}{2}$ lb. per indicated horse-power per hour in a compound marine engine, constructed with an intermediate superheating vessel in accordance with his plans. Nor are we likely to stop long at this point of comparative perfection, for in the early portion of my address I have endeavoured to prove that the theoretical perfection would only be attained if an indicated horse-power was produced with $\frac{1}{3\cdot5}$ lb. of pure carbon, or say $\frac{1}{4}$ lb. of ordinary steam coal.

Here then we have two distinct margins to work upon, the one up to the limit of say 2 lbs. per horse-power per hour, which has been practically reached in some and may be reached in all cases; and the other up to the theoretical limit of $\frac{1}{4}$ lb. per horse-power per hour which can never be absolutely reached, but which inventive power may and will enable us to approach.

Domestic Consumption.—The wastefulness of the domestic hearth and kitchen fire is self-evident. Here only the heat radiated from the fire itself is utilized, and the combustion is generally extremely imperfect, because the iron back and excessive supply of cold air check combustion before it is half completed. We know that we can heat a room much more economically by means of a German stove, but to this it may be very properly objected that it is cheerless, because we do not see the fire or feel its drying effect upon our damp clothing; it does not provide, moreover, in a sufficient degree for ventilation, and makes the room feel stuffy. These are, in my opinion, very potent objections, and economy would not be worth having if it could only be obtained at the expense of health and comfort. But there is at least one grate that combines an increased amount of comfort with reasonable economy, and which, although accessible to all, is as yet very little used. I refer to Captain Galton's "Ventilating Fireplace," of which you observe a diagram upon the wall. This fireplace does not differ in external appearance from an ordinary grate, except that it has a higher brick back, which is perforated at about mid-height to admit warmed air into the fire, so as to burn a large proportion of the smoke which is usually sent up the chimney unburnt, for no better purpose than to poison the atmosphere which we have to breathe.

The chief novelty and merit of Captain Galton's fireplace consist, however, in providing a chamber at the back of the grate, into which air passes directly from without, becomes moderately heated (to 84° Fah.,) and, rising in a separate flue, is injected into the room under the ceiling with a force due to the heated ascending flue. A plenum of pressure is thus established within the room whereby indraughts through doors and windows are avoided, and the air is continually renewed by passing away through the fireplace chimney as usual. Thus the cheerfulness

of an open fire, the comfort of a room filled with fresh but moderately warmed air, and great economy of fuel, are happily combined with unquestionable efficiency and simplicity; and yet the grate is little used, although it has been fully described in papers communicated by Captain Galton, and in an elaborate report made by Général Morin, Directeur du Conservatoire des Arts et Métiers of Paris, which has also appeared in the English language.

The slowness with which this unquestionable improvement finds practical application is due, in my opinion, to two circumstances,—the one is, that Captain Galton did not patent his improvement, which makes it nobody's business to force it into use, and the other may be found in the circumstance that houses are, to a great extent, *built only to be sold and not to be lived in.* A builder thinks it a good speculation to construct a score of houses after a cheap design, in order to sell them, if possible, before completion, and the purchaser immediately puts up the standard bill of "Desirable Residences to Let." You naturally would think that in taking such a house you had only to furnish it to your own mind, and be in the enjoyment of all reasonable creature comfort from the moment you enter the same. This fond hope is destined, however, to cruel disappointment; the first evening you turn on the gas, you find that although the pipes are there, the gas prefers to pass out by the joints into the room instead of by the burners; the water in like manner takes its road through the ceiling, bringing down with it a patch of plaster on to your carpet. But worst of all, the firegrates (of a size irrespective, probably, of the size of the room) absolutely refuse to avail themselves of the chimney flues, preferring to send the volumes of smoke into the room. Plumbers and chimney doctors are now put into requisition, pulling up floors, dirtying carpets, and putting up gaunt-looking chimney-pots; the grates themselves have to be altered again and again, until by slow degrees the house becomes habitable in a degree, although you now only become fully aware of innumerable drawbacks of the arrangements adopted. Nevertheless, the house has been an excellent one to sell, and the builder adopts the same pattern for another block or two in an increasing neighbourhood. Why should this builder adopt Captain Galton's fireplace? It will not cost him much, it is true, and it will save the tenant a great deal in his annual coal bill, not to speak of the comfort it would give him and his family; but nobody demands it of him, it would give him some trouble to arrange his details and sub-contracts, which are all settled beforehand, and so he goes on building and selling houses in the usual routine way. Nor will this state of things be altered until the dwellers in houses will take the matter in hand, and absolutely refuse to put up with builders' ways, or, what is still better, get builders who will put up houses in their way. This is done to some extent by building societies, but there is as yet too much of the old leaven left in the trade, and the question itself too little understood.

Consumption in Smelting Operations.—We now come to the third branch of consumption, the smelting or metallurgical furnace, which consumes about 40,000,000 of the 120 millions of the fuel produced. Here also is great room for improvement; the actual fuel consumed in heating a ton of iron up to the welding point or of melting a ton of steel is more in excess of the theoretical quantity required for these purposes than is the case with regard to the production of steam power and to domestic consumption. Taking the specific heat of iron at ·114 and the welding heat at 2700° Fahrenheit, it would require ·114 × 2700 = 307 heat units to heat 1 lb. of iron. A pound of pure carbon develops 14,500 heat units, a pound of common coal 12,000, and therefore one ton of coal should bring 39 tons of iron up to the welding point. In an ordinary re-heating furnace a ton of coal heats only $1\frac{2}{3}$ ton of iron, and therefore produces only $\frac{1}{23}$rd part of the maximum theoretical effect. In melting one ton of steel in pots $2\frac{1}{4}$ tons of coke are consumed, and taking the melting point of steel at 3600° Fahrenheit, the specific heat at ·119, it takes ·119 × 3600 = 428 heat units to melt a pound of steel; and taking the heat-producing power of common coke also at 12,000 units, one ton of coke ought to be able to melt 28 tons of steel. The Sheffield pot steel melting furnace therefore only utilizes $\frac{1}{70}$th part of the theoretical heat developed in the combustion. Here, therefore, is a very wide margin for improvement, to which I have specially devoted my attention for many years, and not without the attainment of useful results. I have since the year 1846, or very shortly after the first announcement of the dynamical theory, devoted my attention to a realization of some of the economic results which that theory rendered feasible. I fixed upon the regenerator as the appliance which, without being capable of reproducing heat when once really consumed, is extremely useful for temporarily storing such heat as cannot be immediately utilized in order to impart it to the fluid or other substance which is employed in continuation of the operation of heating or of generating force.

Without troubling you with an account of the gradual progress of these improvements, I will describe to you shortly the furnace which I now employ for melting steel. This consists of a furnace bed made of very refractory material, such as pure silica sand and silica or Dinas brick under which four regenerators or chambers filled with checkerwork of brick are arranged, in such a manner that a current of combustible gas passes upward through one of these regenerators, while a current of air passes upwards through the adjoining regenerator, in order to meet in combustion at the entrance into the furnace chamber. The products of combustion, instead of passing directly to the chimney, as in an ordinary furnace, are directed downwards through the two other regenerators on their way towards the chimney, where they part with their heat to the checkerwork in such manner that the highest degree of heat is imparted to the upper layers, and that the gaseous products reach the chimney comparatively cool (about 300° Fah.) After going on in this way for half an hour, the currents are reversed by means of suitable reversing valves, and the cold air and combustible gas now enter the furnace chamber, after having taken up heat from the regenerator in the reverse order in which it was deposited, reaching the furnace, therefore, nearly at the temperature at which the gases of combustion left the same. A great reversion of temperature within the regenerative chambers is the result, and the two first-mentioned regenerators are heated to a higher degree than the latter. It is easy to conceive that in this way heat may be accumulated within the chamber to an apparently unlimited extent, and with a minimum of chimney draught.

Practically the limit is reached at the point where the materials composing the chamber begin to melt; whereas a theoretical limit also exists in the fact that combustion ceases at a point which has been laid down by St. Clair Deville at 4500° F., and which has been called by him the "point of dissociation." At this point hydrogen might be mixed with oxygen, and yet the two would not combine, showing that combustion really only takes place between the limits of temperature of about 600° and 4500° F.

To return to the regenerative gas-furnace. It is evident that there must be economy where, within ordinary limits, any degree of heat can be obtained, while the products of combustion pass in the chimney only 300° hot. Practically, a ton of steel is melted in this furnace with 12 cwt. of small coal consumed in the gas-producer, which latter may be placed at any reasonable distance from the furnace, and consists of a brick chamber containing several tons of fuel in a state of slow disintegration. In large works a considerable number of these gas-producers are connected by tubes or flues with a number of furnaces. Collateral advantages in this system of heating, which is now extensively used in this and other countries, are, that no smoke is produced, and that the works are not encumbered with solid fuel and ashes.

It is a favourite project of mine, which I have not had an opportunity yet of carrying practically into effect, to place these gas-producers at the bottom of coal-pits. A gas shaft would have to be provided, to conduct the gas to the surface, the lifting of coal would be saved, and the gas in its ascent would accumulate such an amount of forward pressure that it might be conducted for a distance of several miles to the works or places of consumption. This plan, so far from being dangerous, would insure a very perfect ventilation of the mine, and would enable us to utilize those waste deposits of small coal (amounting on the average to 20 per cent.) which are now left unutilized within the pit.

Another plan of the future which has occupied my attention is the supply of towns with heating gas for domestic and manufacturing purposes. In the year 1863 a company was formed, with the concurrence of the Corporation of Birmingham, to provide such a supply in that town at the rate of 6*d.* per 1,000 cubic feet; but the bill necessary for that purpose was thrown out in committee of the House of Lords, because their lordships thought that if this was as good a plan as it was represented to be, the existing gas companies would be sure to carry it into effect. I need hardly say that the existing companies have not carried it into effect, having been constituted for another object, and that the realization of the plan itself has been indefinitely postponed. It has, however, lately been taken up and partly carried into effect at Berlin.

Coal Question.

Having now passed in review the principal applications of fuel, with a view chiefly to draw the distinction between our actual consumption and the consumption that would result if our most improved practice was made general; and having, moreover, endeavoured to prove to you what are the ultimate limits of consumption which are absolutely fixed by theory, but

which we shall never be able to realize completely, I will now apply my reasoning to the coal question of the day.

In looking into the "Report of the Select Committee appointed to Inquire into the Causes of the present Dearness of Coal," we find that in 1872 no less than 123,000,000 tons of coal were got up from the mines of England and Wales, notwithstanding famine prices and the colliers' strikes. In 1862 the total getting of coal amounted to only 83,500,000, showing a yearly average increase of consumption of 4,000,000 tons. If this progressive increase continues, our consumption will have reached, thirty years hence, the startling figure of 250,000,000 tons per annum; which would probably result in an increase of price very much in excess of the limits yet reached. In estimating last year's increase of price, which has every appearance of being permanent, at 8*s.* per ton all round, and after deducting the 13,000,000 tons which were exported abroad, we find that the British consumer had to pay £44,000,000 more than the market value of former years for his supply of coal,—a sufficient sum, one would think, to make him look earnestly into the question of "waste of fuel," which, as I shall presently be able to show, is very great indeed. The select committee just quoted sums up its report by the following expression:—"The general conclusion to be drawn from the whole evidence is, that though the production of coal increased in 1872 in a smaller ratio than it had increased in the years immediately preceding, yet if an adequate supply of labour can be obtained, the increase of production will shortly keep pace with that of the last few years."

This is surely a very insufficient conclusion to be arrived at by a select parliamentary committee after a long and expensive inquiry, and the worst of it is, that it stands in direct contradiction with the corrected table given in the same report, which shows that the progressive increase of production has been fully maintained during the last two years, having amounted to 5,826,000 for 1871, and 5,717,000 for 1872; whereas the average increase during the last ten years has only been 4,000,000 tons! It is to be hoped that Parliament will not rest satisfied with such a negative result, but will insist on knowing what can be done to re-establish a proper balance between demand and supply of coal, in preventing its conversion into smoke or other equally hurtful or useless forms of energy.

In taking the 105 million tons of coal consumed in this country last year for our basis, I estimate that, if we could make up our minds to consume our coal in a careful and judicious manner, according to our present lights, we should be able to reduce that consumption by 50 million tons. The realization of such an economy would certainly involve a very considerable expenditure of capital and must be a work of time; but what I contend is, that our progress in effecting economy ought to be accelerated, in order to establish a balance between the present production and the ever-increasing demand for the effects of heat.

In looking through the statistical returns of the progressive increase of population, of steam power employed, and of production of iron and steel, &c., I find that our necessities increase at a rate of not less than 10 per cent. per annum, whereas our coal consumption increases only at the rate of 4 per cent., showing that the balance of 6 per cent. is met by what may be called our "intellectual progress." Now, considering the enormous margin for improvement before us, I contend that we should not be satisfied with this rate of intellectual progress, which involves an annual deficit of 4 million tons to be met by increased coal consumption, but that we should bring our intellectual progress up to the rate of our industrial progress, by which means we should make the coal production nearly a constant quantity for several generations to come; by which time our successors may be expected to have effected another great step in advance towards the theoretical limit of effect, which, as we have seen, lays so far above any actual result which we have as yet attained to, that an annual consumption of 10 million tons would give more than the equivalent of the heat energy which we actually consume.

Solar Heat.

I have endeavoured to show, in the early part of this lecture, that all available energy upon the earth, excepting the tidal wave, is derived from the sun, and that the amount of heat radiated year by year upon our earth could be measured by the evaporation of a layer of water 14 feet thick spread over the entire surface, which again would be represented by the combustion of a layer of coal 1 foot in thickness covering our entire globe. It must, however, be taken into account that three-fourths of this heat are intercepted by our atmosphere, and only one-fourth reaches the earth itself. The amount of heat radiated away from the sun would be represented by the annual combustion of a thickness of coal 17 miles thick, covering its entire surface, and it has been a source of wonderment with natural philosophers how so prodigious an amount of heat could be given off year after year without any appreciable diminution of the sun's heat having become observable.

Recent researches with the spectroscope, chiefly by Mr. Norman Lockyer, have thrown much light upon this question. It is now clearly made out that the sun consists near the surface, if not throughout its mass, of gaseous elementary bodies, and in a great measure of hydrogen gas, which cannot combine with the oxygen present, owing to great elevation of temperature (due to the original great compression), which has been estimated at from 20,000° to 22,000° F. This chemically inert and comparatively dark mass of the sun is surrounded by the photosphere, where the gaseous constituents of the sun rush into combustion, owing to reduction of temperature in consequence of their expansion and of radiation of heat into space. This photosphere is surrounded in its turn by the chromosphere, consisting of the products of combustion, which, after being cooled down through loss of heat by radiation, sink back, owing to their acquired density, towards the centre of the sun, where they become again intensely heated through compression, and are "dissociated" or split up again into their elements at the expense of internal solar heat. Great convulsions are thus continually produced upon the solar surface, resulting frequently in explosive actions of extraordinary magnitude, when masses of living fire are projected a thousand miles or more upward, giving rise to the phenomena of sun spots and of the corona which is visible during the total eclipses of the sun. The sun may therefore be looked upon in the light of a gigantic gas-furnace, in which the same materials of combustion are used over and over again.

It would be impossible for me at this late hour to enter further upon speculations regarding the "regeneration of the sun's heat upon its surface," which is a question replete with scientific and also practical interest, but we should remember that nature is our safest teacher, and in trying to comprehend the great works of our Creator we shall learn how to utilize to the best advantage those stores of potential energy in the shape of fuel which have providentially been placed at our disposal.

THE PRACTICAL NOTE-BOOK OF TECHNICAL INFORMATION USEFUL TO STUDENTS AND WORKMEN.

(64.)

ORNAMENTAL Cut Wood-work with Working Lines and Centres.—In continuation of our series of designs we give in fig. 280 one for an eaves board, or terminal points for the boarding of a shedding. Let *a b* be the centre line of the design; divide this into five equal parts as shown. Through the first of these draw at right angles to *a b* the line *c d*. Make the breadth of the piece *e f* equal to one of the divisions on *a b*, as *a* 1, half being given on each side of the line *a b*. Divide 1 *e* into three equal parts, *a d*, with one of these from *e* and *f*, describe arcs *f h e*, *e g i*. Then on the former point (4), on the line *a b* draw a line *j j n* parallel to *c d*, and join *i j*, *i j*. With the distance *e* 1 set off on the line *c d* to *k* and *l*, and through *k* draw the line *k o* parallel to *a b*. From the point *t*, describe the semi-circular line, and join *m n*. From *s* drop a perpendicular to *t*, making *s t* equal to *s e*, and from the point *u*, where the line *o k* cuts a line drawn through the point *a*, with radius *w t*, describe the arc *v t*. Finish as in the drawing, the remainder of the arcs and lines being part of the divisions in 1 *e*.

In fig. 281 we give the drawing of a bracket, of which *a b* is the extreme breadth, and which is divided into fifteen equal parts. From *a* draw *a b'* at right angles to *a b*, and make *a b'* equal to *a b*. Through the point 4, on the line *a b*, draw a line 4 *c*, and make 4 *c* equal to 4 *a*, and through *c* draw a line *c e* at right angles to *a b'*. At the points *d* and *e* draw circles the diameter of which is equal to one of the parts on *a b*, and even touching the line *a b*, *a b'*. From point *c* describe a circle touching the small circle *d* and *e*. From the point *a* draw a line, *a f*, at an angle of 45° to the line *a b*, and on this line, *a f*, describe the circle and arcs shown. From the points *g*, on line *a b'*, and 14 on line *a b*, set off on the lines drawn from these points to *h* and *i*, and from *h* and *i* as centres describe arcs cutting in the point *f*, from which, with same radius, describe the arc *h k i*. By trial find the centre of a circle which will touch the line *a b* at a point, as *b*, and the arc *h k i* at a point, as *k*; through the centre, *m*, of this, draw a line in *k* parallel to *a f*. Do the same at the centre, *n*, of the circle

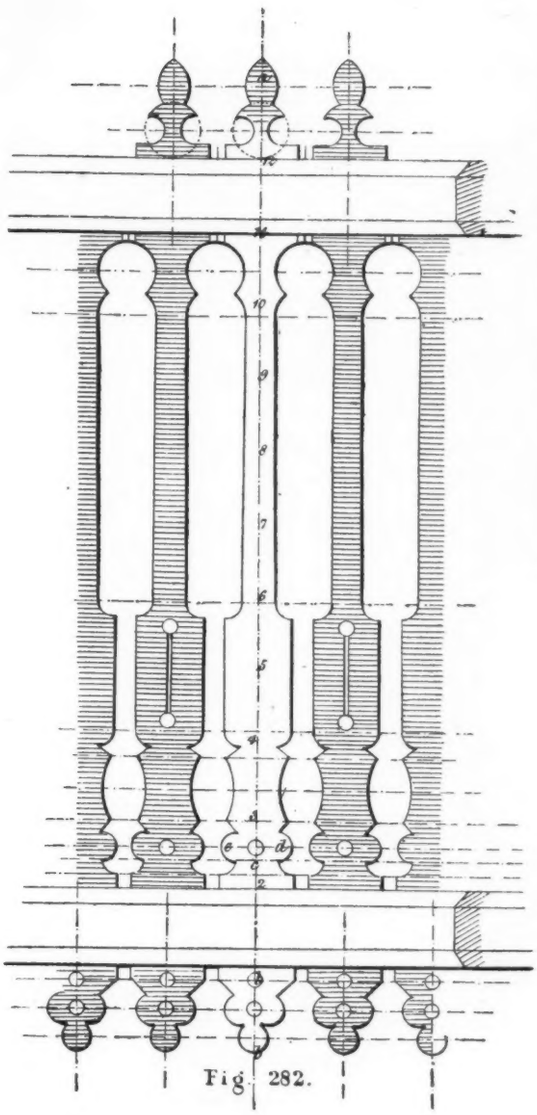
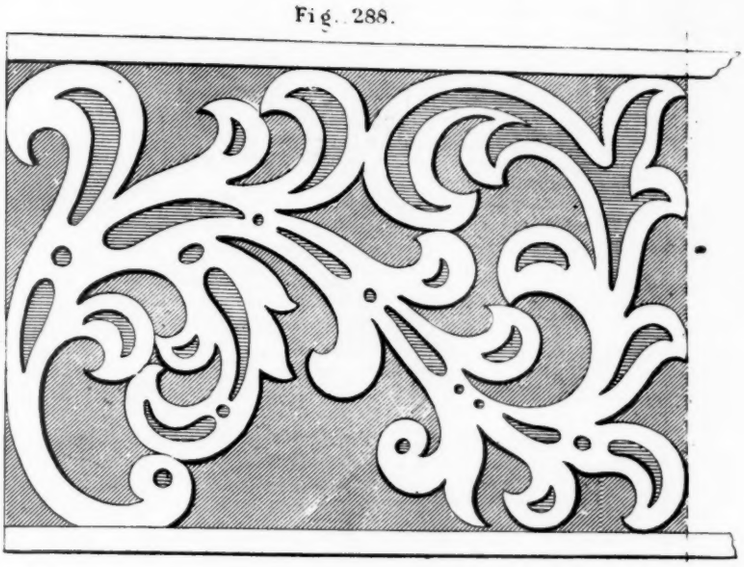


Fig. 282.

Fig. 288.



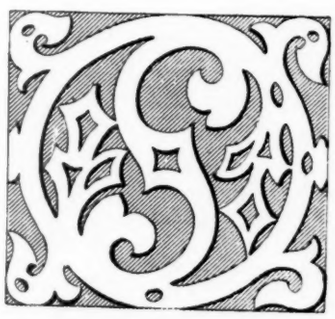


Fig. 287.

Fig. 289

Fig. 290.

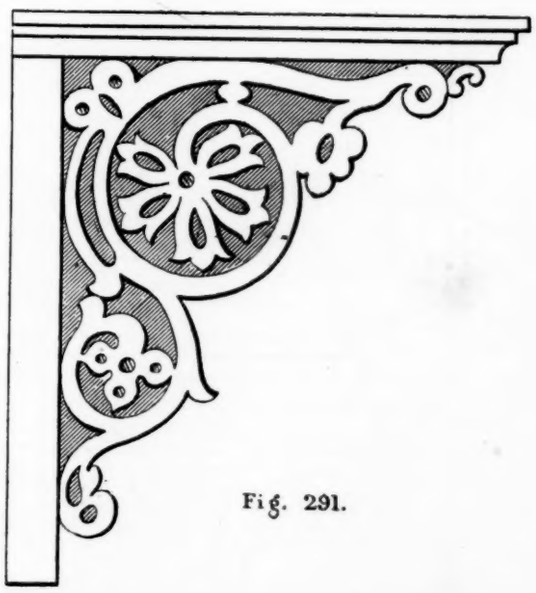


Fig. 291.

o o on the lines *m k*, *n o*; the centres of the arcs forming the spiral terminations will be found. On a line drawn through the point 13, the centres of arcs, finishing the scroll, will be found. Finish as in the drawing.

In fig. 282 we give a design for a rail or paling, with the centre lines marked, the height, *a b*, being divided into thirteen equal parts, the various radii of the arcs and the distances being obtained from these or parts of these.

In continuation of our suggestive sketches begun in our last number, we give in figs. 283, 284, and 285, three for "terminal" ornaments, suitable either for the top or bottom of eaves-boards, palings, or balcony-rails, the point *a* being either

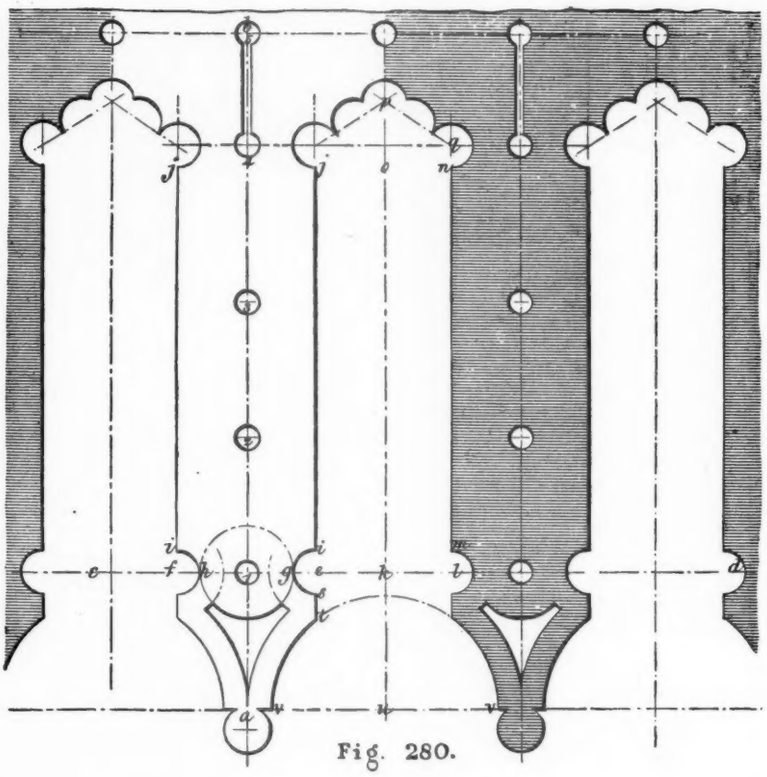
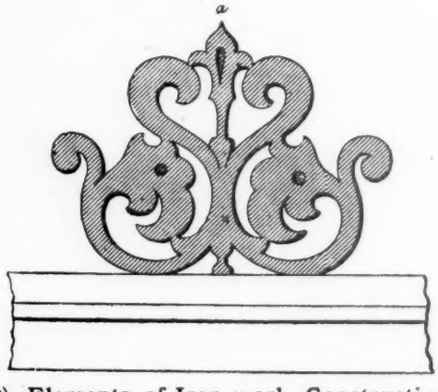


Fig. 280.

upwards or downwards, according to the purpose for which they are used; in figs. 286, 287, and 288, designs for "centre-pieces;" in figs. 289, 290, and 291, designs for brackets; in fig. 292 a design for a "balcony-rail" or paling; and in fig. 293 a design for a balcony front.

Fig. 283.



(65). **Elements of Iron-work, Constructive and Ornamental.**—In continuation of our notes and illustrations on this subject, we give in fig. 294 the lower part of a built wrought-iron beam adapted for a bridge of between 80 ft. and 90 ft. span, and in fig. 295 the upper part of the beam: the height of the beam from *a*, fig. 294, to *b*, fig. 295, is nearly 7 ft.; the width of flanges 2 ft.; the angle iron *e*, 4 in. by 4 in. by $\frac{3}{4}$ in.

Fig. 294 also illustrates the mode of connecting the cross road-

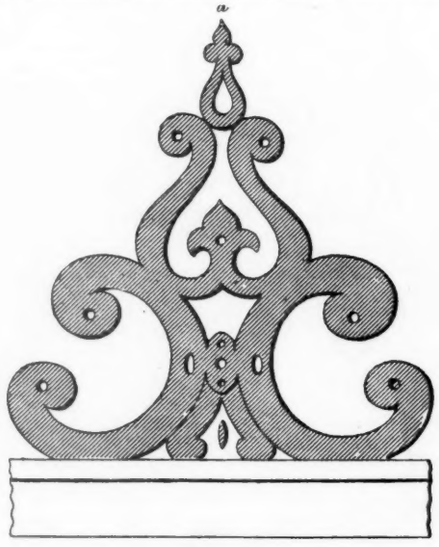


Fig. 284.

way girders *f f* to the main girders *g*; the angle iron *h* of the cross girder *f f* is 3 in. by 3 in. by $\frac{1}{8}$ in., and the thickness of the

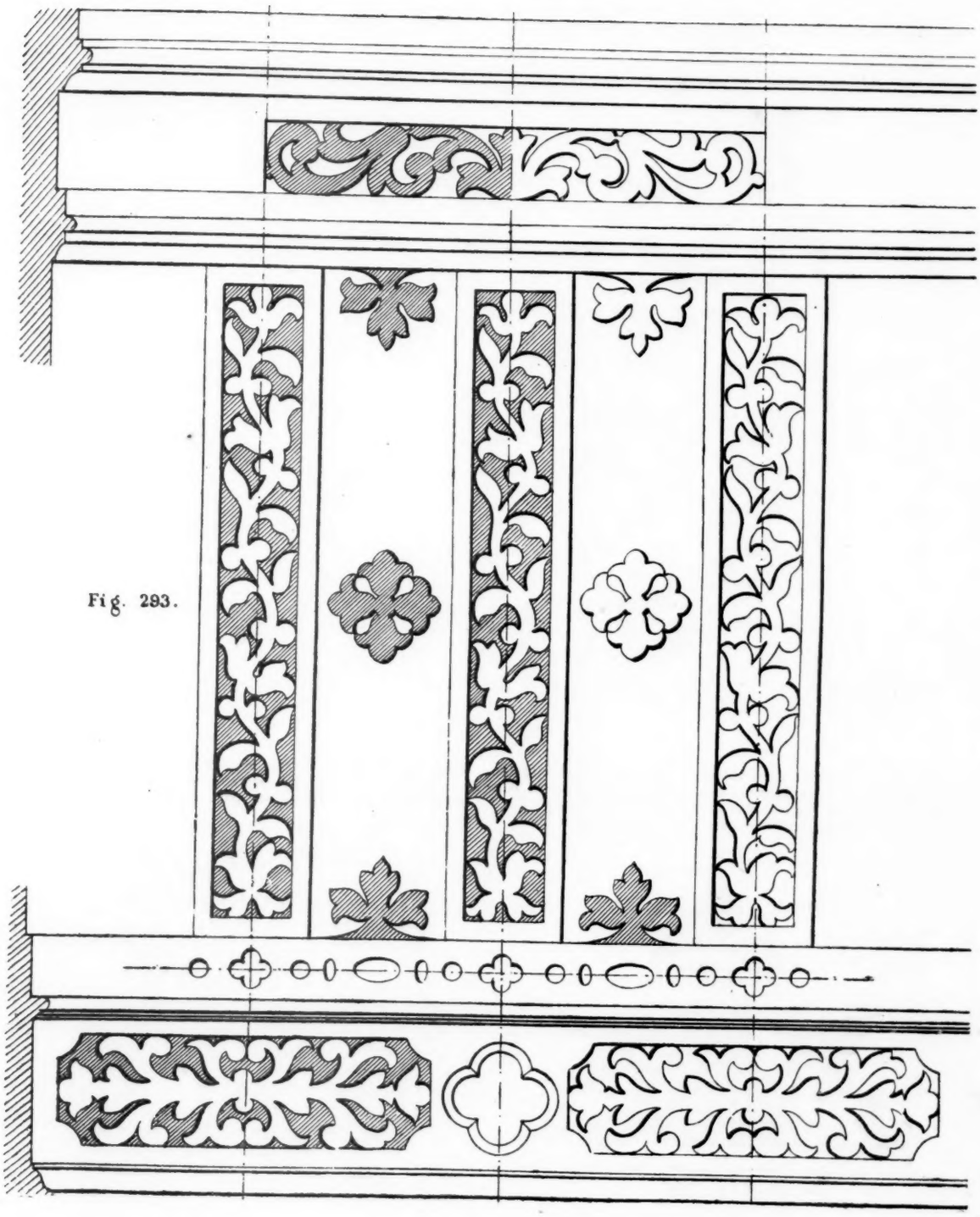


Fig. 293.

plate or central web *i* is ½ in. A cross section of the girder *f f* is given in fig. 296. Of beams constructed of wrought-iron, having illustrated the forms known as "plate" or "built" beams, and "box" or "hollow" beams, we now illustrate two forms of the "lattice" or "open built" beams in figs. 297 and 298. Of other forms, and of the merits or demerits of those arrangements now given, we shall have more to say in another note. In figs. 297, 298, *a a* gives part of the elevation of each, *b b* plan of top plate beam. In fig. 299 we give at A elevation on an enlarged scale of the part *c* in fig. 297, and at B in fig. 299 section of A on the line *a' b'*. In fig. 300 we give an inside view of the end *a' a'* of fig. 297; *a a* the top plate, *b b* bottom plate, *c c* top

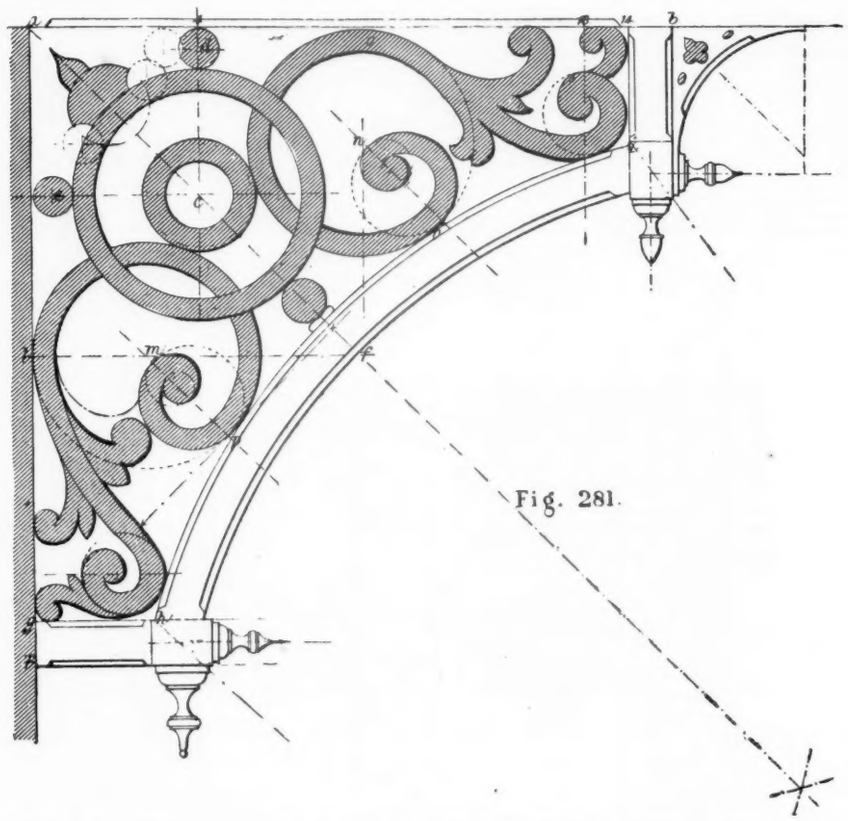


Fig. 281.

angle-irons, *d d* bottom angle-irons, *e e* diagonal bar. In fig. 301 we give to an enlarged scale, one-fourth full size, at A a front elevation of the end *a' a'* in fig. 298. The lower plate *a a* or "bar," is rectangular in section; the end upright or vertical

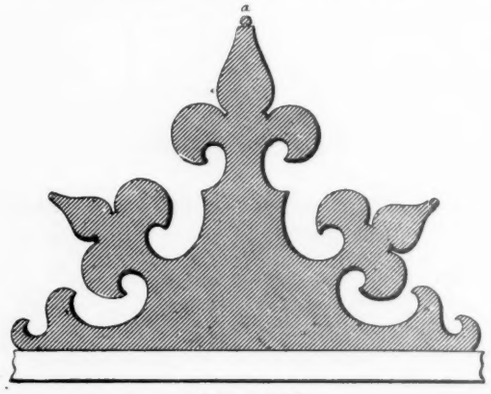


Fig. 285.

b b is "angle-iron;" the upper plate *c c* "T-iron," and the diagonal bar *d* "bar-iron." In B, fig. 301, we give vertical sections on the line *a' b'* in A; the corresponding letters indicating corresponding parts. In C, fig. 301, *e e* is cross section of the angle-iron *b b* in A; *f f g* is elevation, showing junction of bottom bar and vertical T-irons at the point *c* in fig. 298, *f b* being the bottom bar, *g* the angle-iron, this being shown in section at the right. In fig. 302 we give in elevation and section an enlarged view of the upper part of the beam in fig. 298; in

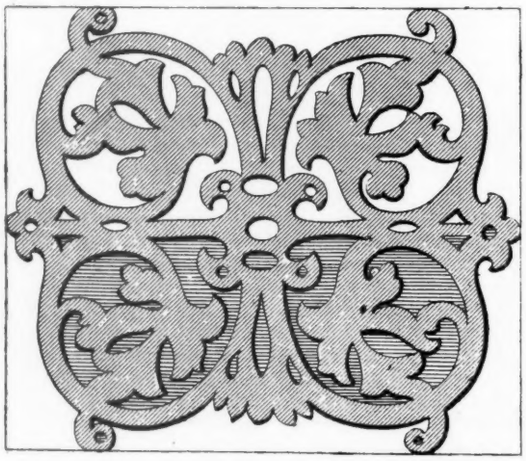


Fig. 286.

fig. 302 *a a* is the horizontal "T-iron," *b b* the vertical "T-iron." If the reader will refer to our memoranda upon beams, he will find the strains to which they are subjected explained. As a rule, the strains which are to be met in the designing of beam

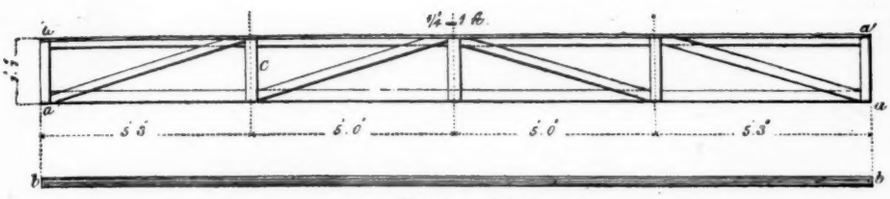


Fig. 298.

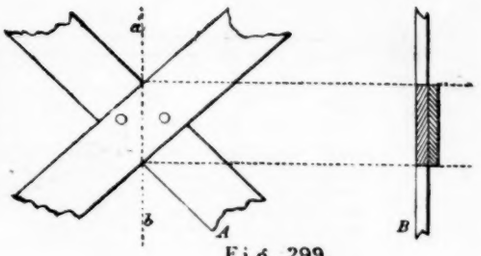


Fig. 299.

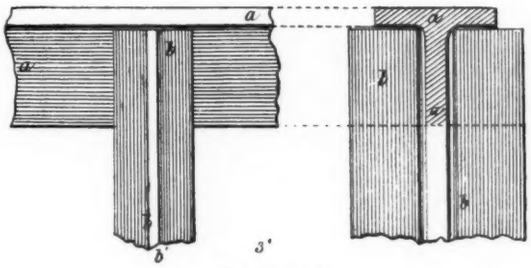
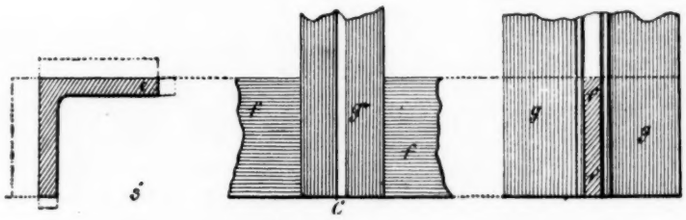


Fig. 302



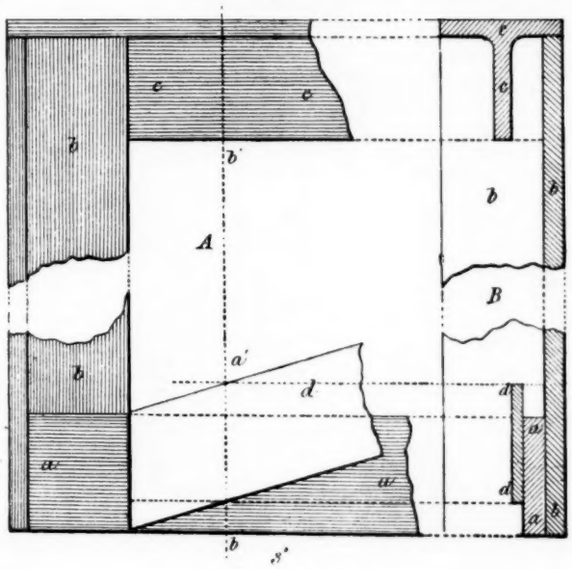


Fig. 301.

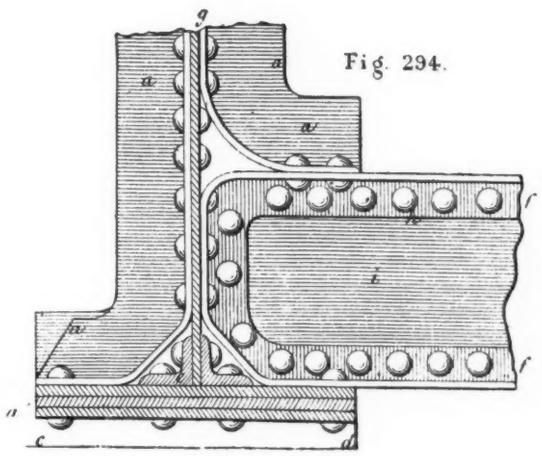


Fig. 294.

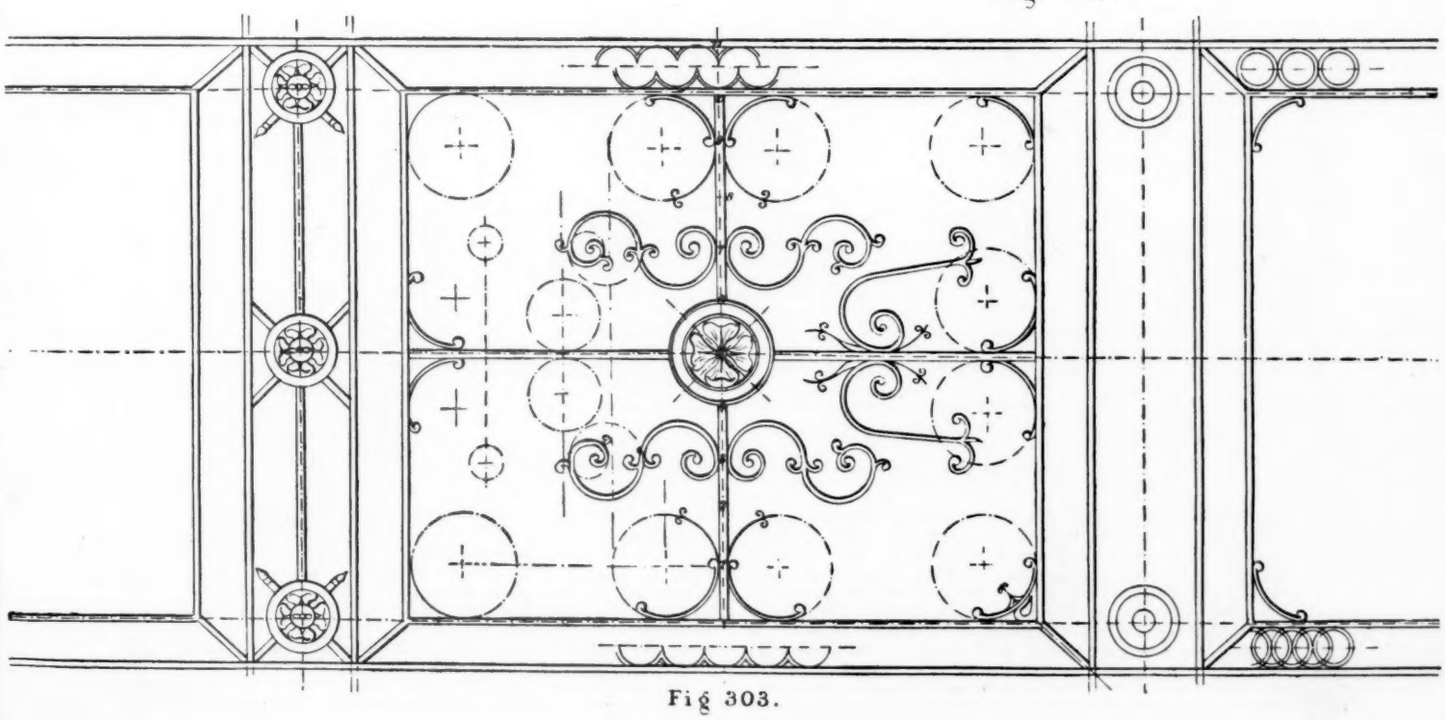


Fig 303.

work are confined to two—tensile and compressive—and the same may be said of all kinds of machine framing, although this is sometimes—although not often—subjected to a third strain: that of torsion, or the strain which tends to weaken a part by twisting it. Beam work is almost now entirely made of iron in one of its two forms of cast and wrought, or with a combination of the two; but where the spans are wide, chiefly of wrought-iron. So also is framing for all kinds of machines. Timber for this kind of work is now seldom or never employed, although it is still so frequently in beam work where the spans are not great, and especially in districts where the material is plentiful. But it is with ironwork we have here specially to deal.

The reader will find in our memoranda on cast and wrought-iron, tables and statements showing their relative strength or capabilities to resist the tensile and compressive strains. From these he will see that cast-iron is specially characterized

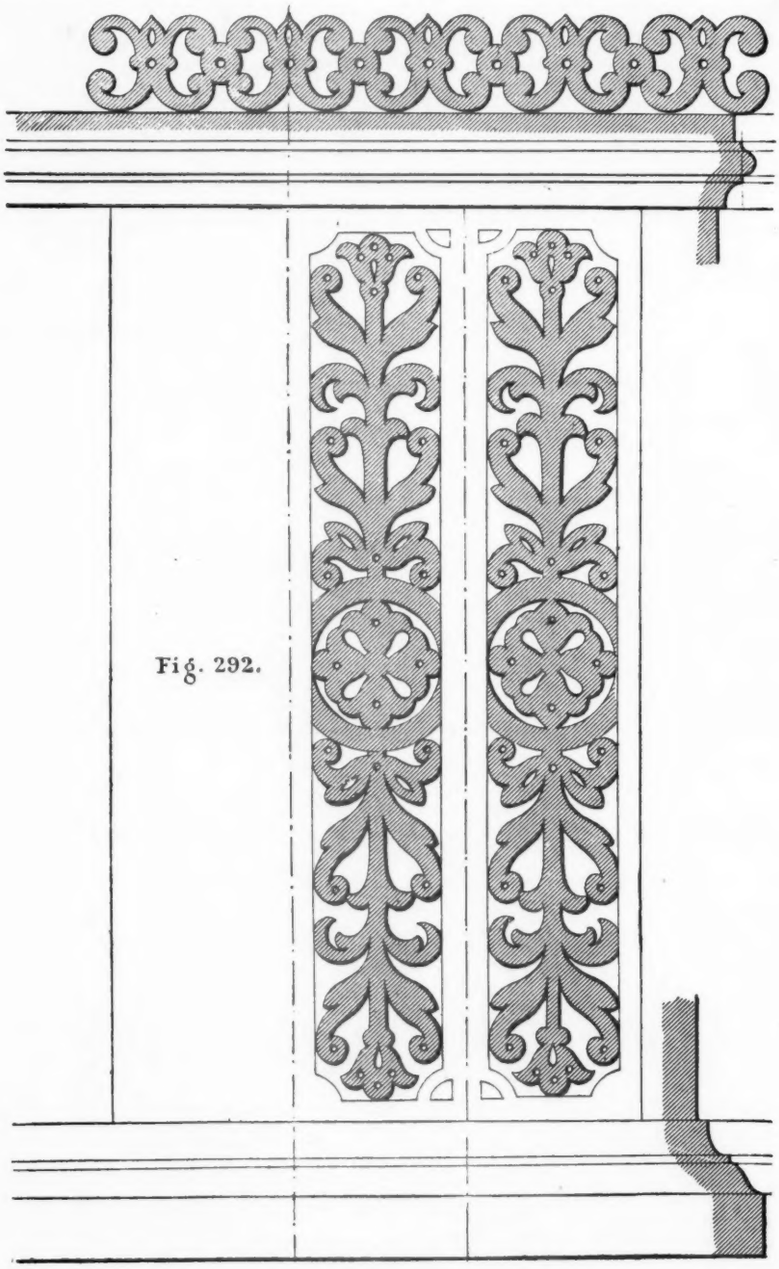


Fig. 292.

by its great power to resist compressive as compared with that to resist tensile strains, the power to resist compression being at least six times that which it has to resist tension. The means of a wide range of experiments show that the tensile power of cast-iron is only 15,000 lbs. per square inch, that to resist compression 85,000 lbs. The value of wrought iron consists in the great resistance which it offers to strains of tension, this power being put down at 65,000 lbs. per square inch of section. Hence, in designing framework in which iron is employed, cast-iron, when used, is used in positions where its powers to resist compression come best into play, wrought-iron where its power to resist tension is best displayed. In beam-work a combination of these two forms of iron is not usually now adopted, although we find, in the case of cast-iron beams, wrought-iron rods used where the beam is trussed; but as a rule, where the main part of the work is in cast-iron, the whole is of

this metal, and where wrought-iron is adopted, it is used throughout. Considerable sources of danger being found to arise where a combination of the two materials is used; as in the case of trussed beams above alluded to. In the case of the framing of roofs, a combination of the two metals is often met with, the struts or braces being of cast-iron, while the tie-rods, &c., are of wrought-iron, cast-iron being also used for convenience of working in the rafter boxes. In machine framing, cast-iron, as a rule, is adopted, this arising from the ease with which complicated forms or arrangement of parts, and ornamentation, both of design and in detail, can be cast. But where combinations of cast and wrought-iron are adopted, the obvious rule is to use cast-iron for the parts which are required to resist compression, wrought-iron to resist tension.

Fig. 296.

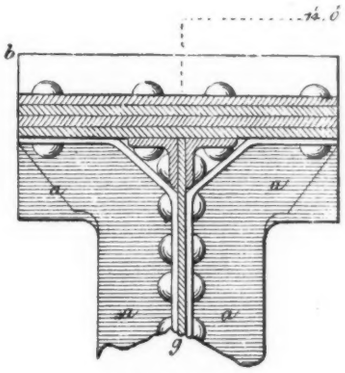
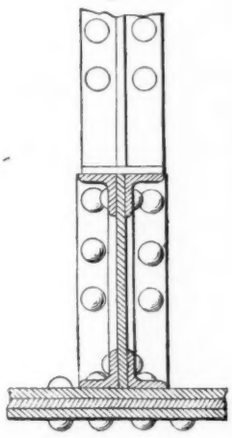


Fig. 295.



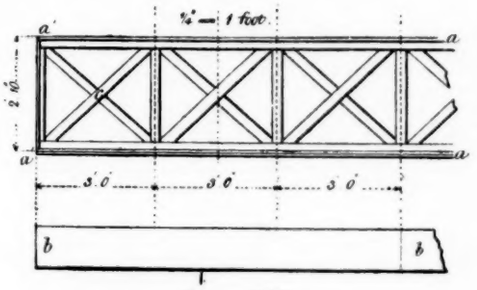


Fig. 297.

But it often happens in the case of machine framing that cast-iron is used throughout; in such a case care must be taken to strengthen the parts subjected to tensile strains, and this by an increase in the section of metal, which, bearing in mind the proportion of tensile to compressive strength of this material, shows that the increase should be at least six times, as compared with those parts subjected only to compression. But it may just happen that the part so strengthened may, by an excess of metal which it receives, form an ugly feature in the framework, rendering it displeasing to the eye as a design. In such cases wrought-iron may be substituted for cast at those parts subjected to tension; and this may be done in such a way, so that the substitution of one kind of iron for that of another may add to rather than detract from the ornamental character of the general

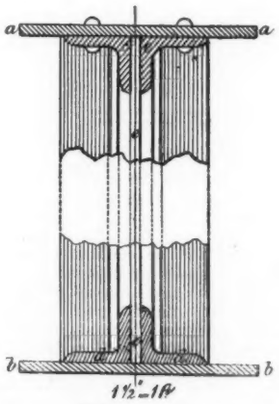


Fig 300.

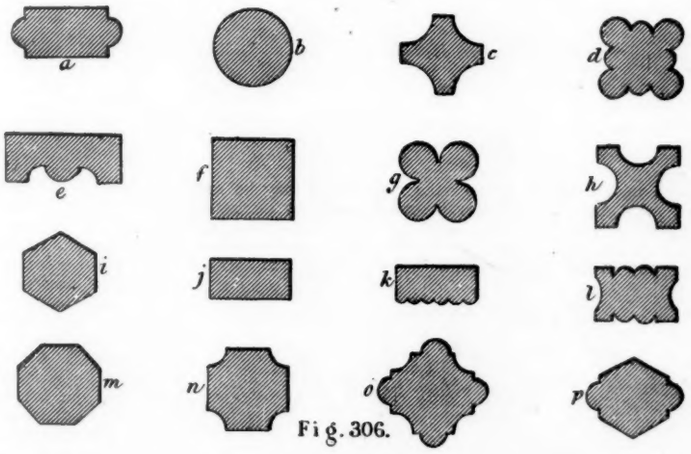
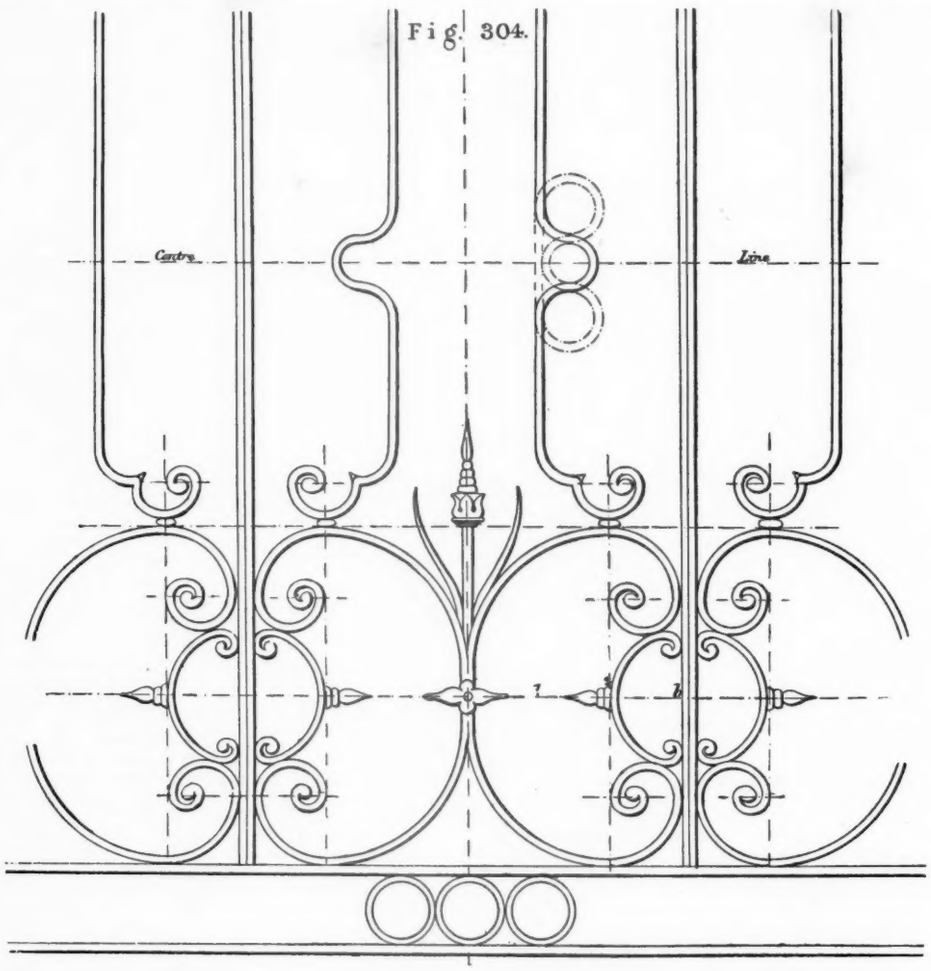


Fig. 306.

design. As a rule, however, there are practical difficulties in carrying out combinations of wrought and cast-iron. These two kinds of iron are, it must be remembered by the designer of framing in which iron alone, to the exclusion of wood, is used, essentially different in character, differing in rigidity, hardness, and flexibility: and markedly in the different degrees in which they suffer under changes of temperature. Take, for example, the difference in flexibility between the two kinds of iron; cast-iron having only one-tenth that of wrought, it may easily be seen how under great strains there will be a considerable difference in the extent to which the two will yield, affecting the elongation of the parts under considerable changes of temperature. To some mechanics the giving of the due proportions to the various parts of a framework composed of the two kinds of iron under notice, so that each will be best calculated to resist the strains to which it may be subjected, seems to come intuitively and with such precision, that in practice the combination is effective. But, from what we have said, it will be seen that great care will be required to be exercised in the arrangement of the parts subjected to different strains, in the calculation of these strains, and in the proportioning of metal to resist them.

In another and succeeding "note" will be found a description of the methods by which the directions in which strains are applied and their amounts are ascertained, and to this we now refer the reader. But on the supposition that the kinds of strain to which the different parts of a framework are ascertained, the directions in which they exert their force found, their amount calculated, and the parts proportioned so as to meet these, it is obvious that if the parts are put together in strict accordance with the formulæ which gives their breaking weight, although the parts will, when put together, (see section on modes of joining parts and riveting and placing them together,) remain *in situ* and in equilibrium, there will be no margin for contingencies, such as shocks, vibratory movements, an increase of load or weight,

Fig. 304.



to which under certain circumstances the parts may be subjected. An allowance is therefore made either by increasing the breaking weight of the beam or by reducing the load which it is to bear. This margin is called the "factor of safety," and in the case of simple beams required to carry a

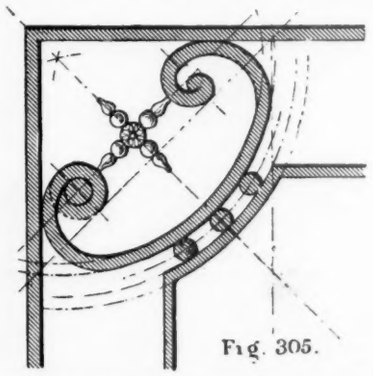


Fig. 305.

load, is found by making this load one-third, or according to some authorities, only one-fourth of the breaking weight of the beam. The usual way is to calculate the strength of a beam to carry a certain load or to sustain a certain pressure, and to make this load one-third or one-fourth—the latter we recommend, as it is better to err on the side of safety—of the weight which the result of the formula shows to be the breaking weight of the beam. In other words, suppose the beam is to carry an actual load of sixty tons, multiply this by three or four, and then find the section of a beam the breaking weight of which will be equal to this sum.

Beams, especially when required to be made in considerable numbers, are generally subjected to testing before they are sent out from the yard of the maker, the conditions of testing being usually given by the engineer or architect, each beam being subjected to loads which bear a certain proportion to the breaking weight. Sir W. Fairbairn has done good service by pointing out the dangers arising from over-testing, as this is apt to weaken the beams. A very little consideration will show that beams when separately tested and subjected to too severe a test, will be weakened in their structure. To those desirous to pursue the subject further, we refer them to p. 163 of Sir William Fairbairn's work "On the application of Wrought and Cast-iron in Building Purposes," London, Longmans and Co.

But while certain arrangements of framework, such as beams for supporting steady weights, may have applied to them the "factor of safety" only, the amount of which we have already stated, some framing is subjected to other conditions, such as repeated vibrations or shocks, so that the parts will have to be designed with a view to this; hence comes in the use of the "factor of stability." While in some framings one part may have to be calculated under the "factor of safety," another part under that of stability, there is very great diversity of opinion amongst authorities in framework construction as to what are or should be, the value of these factors. In machine framing the factor of safety will obviously depend upon the character of the work which the machine has to do; but as a rule the working strains being calculated, the factor of stability will be from six to fifteen times the working strains, according as the framework is subjected to severe and sudden strains and

shocks. In another note we shall continue our remarks on this important department of ironwork.

"*Subsection, Ornamental Ironwork.*"—In fig. 303 we give elevations of a wrought-iron balustrade with centres, &c., marked; in fig. 304 another design; in fig. 305 a design for a "corner-piece;" and in fig. 306, sections showing various forms of balcony and other rails.

TECHNICAL EDUCATION FOR ENGINEERS, MINERS, &c.

LOOKING over the statistical report of the American National Association of Iron Manufacturers for 1872, we find a statement of the opening of a school of mines at Rolla, Phelps County, the principal features of which are such that we deem them worthy of the notice of our readers. Possibly in no other country in the world is there such an extensive field as in England for the development of practical acquirements, by adding thereto the knowledge which the researches of our philosophers and scientific men have made available for the benefit of our manufacturers, mechanics, miners, agriculturists, &c. True, also, is it, we believe, that there are chairs of physics and applied mathematics at some of our universities; true, too, that we have a Geological Museum, where, from time to time, courses of lectures are delivered. We have, besides, the Military Engineering College at Woolwich, and Civil Engineering for the Indian service at Cooper's Hill, and Sir Joseph Whitworth has recently founded a noble lot of prizes as incentives to mechanical studies; but a national college of engineering we—the greatest engine manufacturers in the world, the nation which has unquestionably sent forth the pioneers of the railway and telegraph systems over the earth and under the ocean, the country which counts amongst her sons the Watts, the Stephensons, Brunels, and others whose number is legion—do not possess. In France, Germany, Austria, we think also in Italy, and certainly in Sweden, there are public academies or colleges, where the sciences, as applied to mining, metallurgical, and general engineering, are especially taught; and now we find in the West, 113 miles from St. Louis, a school of mines, connected with the university of the state, established at Rolla, and not only established, but already endowed with an income which meets its expenses. We have, unfortunately, no very extended information before us as to the course of studies and practice pursued, but we gather that the school is under the general charge of Professor C. P. Williams and a military commander, Major Albert, formerly of the United States Engineers, who is also professor of applied mathematics and engineering; whilst Mr. N. W. Allen is assistant professor of mathematics, and Mr. W. Cooch assistant in analytical chemistry and assaying. Two more teachers are to be engaged, one for mining, the other for mechanical engineering, and $6,000 have been expended during the last six months on apparatus for demonstration in physics. We note, too, that every student is provided with chemical and surveying instruments for his own use; that good work has been done by the students in surveying the town of Rolla, that they already number upwards of forty, only seventeen being from the town, and that the number would be considerably increased but for the lack of boarding accommodation in the neighbourhood.

Now surely there is something in this endeavour on the part of a small town out in the Far West to supply its young men with what in that district is the most useful species of technical education, worthy of imitation at our great centres of industry, if nowhere else—surely, for instance, at the great strongholds of the coal and iron trades, at Newcastle, Birmingham, Dowlais, Merthyr, Aberdare, the Cleveland district, and other places too numerous to name, where such establishments as the one we have just referred to would be of infinite value in engrafting in practical knowledge the theoretical and scientific discoveries of the age. We have, it may possibly be replied to the above, in all our great manufacturing districts such things as mechanics' institutes and lending libraries, containing books on most of the practical subjects and questions of the day, and to which libraries in many instances the principal employers of the district are the most generous contributors, if not, as it sometimes chances, the sole supporters. But yet we have not a school of actual science, where the sons of the people can obtain, at a cost within their means, that education in physical truths, and knowledge of the fitting mode of their application, which is so necessary for success in life in these days of materialistic prosperity.

That our views on this subject are neither singular nor egotistical, but are shared by some of the great thinkers and workers of the day, we would instance some remarks made by Dr. Williamson, F. R. S., President of the British Association, on his delivering the opening address at the recent meeting of the members of the association at Bradford. Though this address is more particularly dedicated to chemistry, it still in no wise ignores the claims of the students of other sciences to something very much approaching state protection and help. Dr. Williamson says, "We want a system which shall give to the young favourable opportunities of acquiring a clear, and as far as it goes a thorough, knowledge of some few truths of nature, such as they can understand and enjoy—which shall afford opportunity of further and further instruction to those who have best profited by that which has been given to them, and are anxious to obtain more; which shall enable the best students to see what original investigation is, and, if possible, to assist in carrying out some research; and finally, which shall supply to each student who has the power and the will to conduct researches all material conditions which are requisite for the purpose." "The first and most fundamental condition for this is, that the desire of investigators for the acquisition of knowledge be kept alive and fostered. They must not merely retain the hold which they have acquired on the general body of their science, they ought to strengthen and extend that hold by acquiring a more complete and accurate knowledge of its doctrine and methods; in a word, they ought to be more thorough students than during their state of preliminary training. They must be able to live by their work without diverting any of their energies to other pursuits, and they must feel security against want in the event of illness or in their old age." And the learned doctor further proceeds "to describe the outlines of such a system, framed for the sole purpose of promoting research." "Let the most intelligent and studious children from every primary school be sent, free of expense, to the most accessible secondary school for one year; let the best from these be selected and allowed to continue for a second year, and so on until the *élite* of them have learned all that is to be learned there to advantage. Let the best pupils from the secondary school be sent to a college of their own selection, and there subjected to a similar process of annual weeding; and finally, let those who get satisfactorily to the end of a college curriculum be supplied with an allowance sufficient for their maintenance for a year, on condition of their devoting their undivided energies to research, under the inspection of competent college authorities, while allowed such aid and facilities as the college can supply, with the addition of money yearly for special purposes. Let all who do well during the first year be allowed similar advantages for a second, and even a third year." We will not say that there is something almost utopian in such a scheme as this, but we will confess that we do not go so far in thus providing for the development of incipient genius and industry as does Dr. Williamson; nor do we imagine that in our time at least any government in the world, however paternal—if that be the proper adjective to use in this case—would seriously contemplate even for a moment such an enormous charge on its revenues as the carrying of such a proposal into practice would entail. On the other hand, however, we contend that there is a possibility, in fact an easy practicability, of forming such schools or Lycées for the education of our young people in such actual sciences as those connected with engineering generally, which would place the facilities for improvement within the reach of all. At the moment scarcely any one will deny that the only fields for practical education in mechanics are the foundries, rolling mills, and fitting shops of our great manufacturing firms; indeed, one has only to look at the constant recurrence of the words, "Has passed through the shops," used as a species of credential by young men seeking employment, to be forced to the conclusion that this passing through the shops is the recognized curriculum for engineering (especially mechanical) studies. Now, we have infinite respect for the genius, talent, and skill, which in most instances conduct and direct these marvellous creative factories in which so many of the triumphs of our best-known engineers have been achieved; but it will not surely be denied that there is a species of sectarianism pervading them—a clinging in certain districts to certain fashions; a limitation, if we may be allowed the word, both of design and execution, to certain locally or personally accepted formulæ which are at variance with the abstract teaching of truth, or the exposition of those broad principles of physical science which are in reality as unchangeable as they are true. It must not, however, be for a moment supposed that in our conception of what would really constitute a theoretical as well as a practical education for engineers we would abrogate or do away with this passing through the shops. On the contrary, the colleges or seats of instruction—call them what you will—should be placed near some of the centres of the particular branch of the science they are designed to teach; so that, in addition to the theoretical knowledge imparted, the opportunities of observation

and practice in the actual operative part of the profession might be available. And to this end how much might be made of such establishments as Woolwich, Enfield, or our various dockyards? What we now say will at once absolve us from the impression which might otherwise arise, that we imagined mere study would produce the education required. We certainly do not think so, our opinion being that it alone would no more insure success in acquiring a real knowledge of the profession than swimming is to be learned, as a stay-at-home philosopher is said once to have hoped for, by watching and imitating on a table the movements of a frog in a basin of water.

Another point is the removal of all old and obsolete books or treatises on the subjects taught. The advance in the abstract and practical sciences has been so rapid in recent years, that many books which were regarded in the youth of men not as yet old as text catechisms of absolute truth, are now utterly valueless, and in many cases so absurd as not to be unprovocative of laughter when looked at in the light of present knowledge. How long ago is it since Pinnock's Questions were in use, one of which was, if we recollect correctly, "What are the four elements?" "Earth, fire, air, and water!" Could the force of absurdity go further?

We confess candidly that we do not expect or anticipate that the educational Utopia of Dr. Williamson will ever be localized. At the same time, we certainly hope and trust that something practical will be done by Government, and that soon, towards placing the means of technical education within the reach of all who choose and are fitted to seek it; and if our hopes be realized, we doubt not but that the force of intelligent workers merely added to the producers of the nation will contribute in no small degree to the prosperity and happiness of what is, in reality, the English commonwealth.

If, however, we as a nation are not justly fulfilling our destiny, not justly doing our best for those who are coming after us, there are others of the great human family who are neither so neglectful or so careless of what may be the consequences of such neglect. At the very moment of writing we have before us information of the founding at Yeddo, under the auspices of the Japanese Government, of a college for young men destined to become members of the public works department of that country. There may, and there probably is, even about this institution, a hankering after effect rather than a real desire to do what is best;—the list of professors is certainly a long one, and their names not unknown to science;—there may be traced through the list just a tinge of that official patronage which is so apt to get into grooves.

What we want in this country in reality is an institution, college, or whatever else it may be called, which shall at once, whilst discarding the sectarianism of individual schools, yet be strong enough in power to afford just means of development not only to genius when it does appear, but also to ordinary capacity as it crops up.

At the Crystal Palace, we have reason to think, something is being done in the right direction by the establishment of practical engineering classes. It is a praiseworthy attempt, and, placed as the school is, close to the seething population of London, wherein there must be hundreds of minds that only require means for attaining further acquirements, it ought to become a success. Nothing worth doing can be done at once; and we ought, perhaps, therefore to conclude by saying, that whilst we see the necessity of a government establishment in which engineering, pure and simple, shall be taught, we also see the necessity of that institution being, not merely a collection of names with long rows of letters after them, but a combination of all that is practical in the best sense of the term, and theoretical in another.

Wood-Paper Pulp.—V. E. KEEGAN digests wood or other fibrous matter with caustic alkali under a considerable pressure, whereby disintegration is brought about more readily than by boiling at the ordinary pressure. The wood is cut into pieces half an inch thick, and 6 to 12 inches long; these are heated in an iron digester with caustic soda at 20°, the pressure reaching 50 lbs. per square inch. After half an hour, the wood is further heated in steam to about 300° F. (nearly 150° C.) The resinous matter of the wood is converted into substances soluble in water, and hence is removed by mere washing; the wood is then pulped and the usual operations proceeded with. The soda solution can be used over again, as it takes up but little resin. *Dingler's Polytech. Journal, ccviii.* 316.

[A process very similar to this was tried in England some years ago but was abandoned, at any rate for the time, as the amount of bleach requisite for blanching the pulp and rendering it fit for use was too great. Perfectly white paper can be thus made, however. *Chem. Ed. P. M.*]

PRODUCTION OF CORN.

MR. ALEX. DELMAR, having returned to the United States from a tour made on occasion of his attendance at the Statistical Congress at St. Petersburg, is endeavouring to convince his countrymen that the world is now producing more bread than it can eat, and that greater attention should be turned to other industries. Taking returns for the year 1870, he gives the following statement as representing the cereal product of what he terms the commercial world, throughout which, with little or no restriction, bread stuffs are now produced and exchanged:—Europe, population 302 millions, cereal product 5,335 million bushels, or 17·7 bushels per head; Asia (Turkey and Russia), population twenty-seven millions, cereal product 250 million bushels, or 9·3 bushels per head; Africa (Egypt), population eight millions, cereal product eighty million bushels, or ten per head; Australia, population two millions, cereal product thirty million bushels or fifteen per head; North America, population fifty-two millions, cereal product 1,725 million bushels, or 33·2 per head; Central America, population three millions, cereal product twenty million bushels, or 6·7 per head; South America, population twenty-eight millions, cereal product 217 million bushels, or 7·8 per head; West Indies, population four millions, cereal product *nil;* all the rest, population twenty-six millions, cereal product 200 million bushels, or eight per head; add two millions population of scattered parts open to commerce, and add also seventy million bushels of cereal product imported from the trans-commercial world; total population 428 millions, and cereal product 7,727 million bushels, or upwards of eighteen bushels per head. The rest of the world is either destitute of commercial facilities or closed to intercourse. The calculation, we believe, includes in China and Japan the ports only. "Now," says Mr. Delmar, "the utmost capacity of a population to consume grain in the form of food is eight to ten bushels per caput per annum. What it consumes beyond this amount must be for seed, for the food of animals, for the manufacture of spirits, fermented liquors, sugar, or starch, or for fuel. For some of these purposes—as for food, seed, and fodder—the use of grain is necessary; for others—as for starch, sugar, and beverages—its use is, up to a certain point, economical; beyond that, and always when used for fuel, it indicates over production and loss. England contains one of the best fed populations in the world; nevertheless, the entire consumption of grain in England, including the enormous quantities converted into starch and beverages or to food for animals, is less than two quarters (sixteen bushels) per caput per annum, of which the home product is ten bushels; yet the world at large produces nearly nineteen bushels per caput, and the precious staff of life is thrust into the stoves of Western farmers for fuel." Mr. Delmar observes that production has vastly increased since the application of steam in agriculture, and the stimulus supplied by railway communication and industrial progress. In regard to the price of grain he notices the great increase of coin and credit, tending to force up prices, and he puts the world's stock of coin at 1,500 million dollars in 1848; 2,800 millions in 1860, and a much larger amount now. On the other hand, there has been the progress of mechanical inventions, tending to force prices down. Referring to the United States' census years, he says:—"In 1820, 1840, and 1850, respectively, it required twenty-one persons out of every 100 of our population to produce the food needed for the whole; in other words, 21 per cent. of the population were actual agriculturists. During this whole period of thirty years there was no mechanical improvement material enough to dispense with the manual labour of a single husbandman. In 1860 the proportion of agriculturists had fallen to 16¼ per cent., and in 1870 to 15½ per cent., so that now but one person out of 6·46 tills the soil, whereas twenty years ago one out of 4·76 was required. This shows a mechanical improvement equal to about 36 per cent., or little over one-third. Since 1848 the increase of currency and credit in this country has been enough to have at least doubled the price of grain, possibly trebled, or even quadrupled it, while the advance of mechanical improvement in this country has only been sufficient to reduce it about one-third. It is quite a safe computation to say that, if not produced in excess of the demands for its use, the price of grain should have advanced since 1848 at least two-thirds over its price at that time. Yet we find, upon turning to the market reports of the two periods, that the price of corn, the principal grain of the country, was precisely the same at both. It was 67 cents, gold, per bushel, in 1848, and it is 67 cents per bushel, currency, now. If this does not demonstrate over-supply, political economy is a valueless science, and observation in matters relating to breadstuffs must

go for nothing." Mr. Delmar calls attention to the increasing area of land accorded to the culture of tobacco and other superfluous and noxious products; the relatively low wages earned by agricultural labourers; the low prices of cereal products as compared with other commodities and the world's stock of currency; the recent abandonment of agriculture by large masses of people, and the relatively slow advance in the prices of agricultural lands. He maintains that the world is over-producing breadstuffs, and that the fault is mainly attributable to the United States. He says, in conclusion :—"It would not be difficult to show that the entire future of this vast country is bound up in the solution and wise disposition of this question, and I therefore ask in its behalf the most careful consideration of all who may read this communication."

BLEACHING Paper Pulp.—The washed substances to be blanched are put into a weak bath containing 2·5 to 3·3 kilogs. bleaching powder per hectolitre; after six to twelve hours they are washed and boiled for two to four hours with carbonate of soda (650 grammes per hectolitre). If the fibres are very hard they are treated with sulphuric acid (3 kilogs. per hectolitre), and well drained before boiling with the soda. Finally they are placed in a bath of 2·5 to 3·5 kilogs. of bleaching powder, and 0·7 kilogs. of soda per hectolitre for four to six hours.

Another process consists in passing the fibres through an alkaline chlorine bath, containing excess of caustic alkali; 5 per cent. is used for linen, cotton, &c., 25 per cent. for jute and other substances difficult to bleach; the temperature should not exceed 50°. The bath is readily made by adding excess of carbonate of soda to chloride of lime. *Moniteur de la Teinture, xvii.* 130.

PROTECTION of Wood.—Wood is rendered extremely durable and weather-proof, by covering it with hot linseed oil varnish, several coats being applied, each one after the preceding one is dry; finally oil colours are applied as required. The drying requires a longer time than the ordinary process of painting. *Dingler's Polytech. Journal, ccvii.* 515.

STEAM Engines for Spinning Mills.—R. SUTCLIFFE states that on account of the extreme regularity required in the engines for spinning mills, he always employs a two cylinder engine. The steam is best used expansively up to a certain point only, thus to a certain extent sacrificing some of the power of the steam to the regularity of working of the engine. He finds that a high and low pressure compound engine with a low pressure condensing engine working on the same shaft, give the best results with regard to regularity. A compound engine exhibits great superiority over a single cylinder engine. The engine may be made a valuable adjunct to the boiler by using the escape steam to heat the injection water. *Paper read before the British Association, Bradford.*

ECONOMIC Generation of Steam.—R. SUTCLIFFE states that the uses to which a boiler has to be adapted are of such a nature that it is impossible to satisfy one requirement perfectly without to some extent sacrificing another point; thus a boiler has to fulfil the three conditions of being a good steam generator and a capacious reservoir, and of being capable of resisting great pressure. Mechanical firing by means of a fan and blast is, in the author's opinion, the most suitable, from 2½ to 2¼ lbs of coals per horse-power being requisite in the case of the boiler employed by him (evaporative power unknown). *Paper read before the British Association, Mechanical Section, Bradford.*

RAILWAY AMALGAMATION.—B. HAUGHTON objects to Government management, and also to the present system of management. The first is condemned because the work would be immense for any Government department to undertake, and because it would not pay. The second system is considered unequal to the necessities of the age and the wants and demands of the public. As a compromise between both, an amalgamation between four groups is proposed, of which three would run north and south from Inverness to Dover by the London and North-Western, Great Northern, and Midland groups. The Great Western group would extend from Land's End, Liverpool, and Manchester, to London. All four would be in continual competition to a greater or less extent, and such a system, it is considered, would cause a smoothness of action in the railways, and the introduction of all the changes that are of importance, and asked for by the travelling community. *Paper read before the British Association, Bradford.*

The American Engineer and Inventor:

SELECT ABSTRACTS OF PATENTS RECENTLY GRANTED IN THE UNITED STATES.

[*For information concerning this department see the notice on the wrapper below the Contents of the Number.*]

212. Improved Sawing Machine.

This invention consists in the improvement of sawing machines. The table is provided with one or more boards arranged to slide in and out of supports in the under side of it, to hold the work directly in front of the saw when it may be required to do so for cutting slots or notches in the end of the work. This tool may also be used for making long grooves in the work by running it over the cutter on the table.

213. Improved Hoisting Jack.

The object of this invention is to construct a hoisting jack which is easily operated, effective in action, and readily adjusted to different heights. The invention consists of a bell crank, lever with treadle, which acts by means of an intermediate connecting rod, and weighted link on a sliding rack, guided between a strong frame.

214. Improved Automatic Gate.

This invention has for its object to furnish an improved gate, which shall be so constructed that it may be readily opened and closed by simply moving the end of the lever in one and another direction. The invention is an improvement in the class of gates having appliances for swinging them at a distance; and consists in the arrangement of a set of parallel levers and their connecting rods with a pivoted plate, upon which the gate itself is pivoted and partly supported. By this arrangement, by operating either of the levers, the gate is swung open and latches upon the post, and by moving either lever in the opposite direction the gate will be swung shut.

215. Improved Land Marker.

This invention relates to an arrangement of a sliding bar and pivoted lever with the pivoted frame to which the markers are connected. The plows or markers have a free vertical, but no lateral movement. The rear ends of levers pass through keepers attached to a bar, so that the plows or markers may all be raised or lowered at the same time, by raising and lowering the said bar. The bar is attached to the rear ends of two levers which are pivoted to short studs, attached to the rear bar of the frame. The forward ends of the levers are connected by a board for the driver to rest his feet upon, so that he can, with his feet, raise the plows from the ground, to pass an obstruction or for convenience in turning around. To a hand lever is pivoted the forward end of a bar which slides in the slot of an upright, attached to the rear bar of the frame. The bar projects rearwardly, so that, by adjusting it by means of the lever, it can be made to support the plows when raised from the ground; or it can be adjusted to act as a lever for forcing the plows farther into the ground. The slotted upright has several holes formed through it to receive pins, between which the bar slides, so that by adjusting the said pins the bar may be adjusted to support the plows at any desired distance from the ground.

216. Improved Machine for Making Taper Tubes.

This invention consists of a taper mandrel, with a clamp for holding the plate of which the tube is to be formed at one edge, and a lever and bending plate, so contrived that the tapered plate is bent to the form of the mandrel by pressing said bending plate upon it by the lever, the mandrel being shifted around from time to time, and held stationary while the pressing is performed. The invention also consists of a mandrel and holding clamp, a welding roller, and a carriage, so combined and arranged that the bent plate, being reheated and arranged on the mandrel with the edges lapped and adjusted in the carriage, is quickly and thoroughly welded by the pressure of the welding roller, under which the lapped edges are caused to pass forward and backward until the joint is completed.

217. Improved Knob Latch.

The object of this invention is to furnish an improvement in the class of door locks having a sliding spindle with wedge-shaped pieces attached to it. The invention consists in the arrangement of guide pieces in connection with the bolt spindle. The latch bolt consists of three parts: Head, shank, and wedge extension. The head is considerably larger than the shank part, and is acted upon at its rear side by the end of a band spring. The wedge part extends sidewise in a right angle from shank, forming, with guide piece, a square aperture for the knob spindle. Two wedge projections are placed centrally, but in opposite directions, on spindle, and act from both sides on wedge extension. The latter is, therefore, pressed back whether the knob is pressed or pulled, opening thereby the door. A spring presses the bolt forward again as soon as the knob is released. The whole lock is let into the door, which is, as well as the side face plate, provided with slotted perforations.

218. Improved Circular Saw Guards.

The object of this invention is to provide means for protecting the operator in using circular saws: and consists in a guard consisting of two or more pieces. By raising and lowering the guard bar the two guards may be kept nearly in contact with the piece of timber which is being sawn, and all danger from pieces, splinters, or loose knots being thrown toward the operator is prevented.

219. Improved Reversible Rotary Steam Engine.

This invention has for its object to furnish an improved rotary steam engine. To the main shaft is keyed the drum, through slots in the face of which the pistons move in and out. The shaft works in cast-steel bearings made adjustable. The pistons are bolted to yokes, which work upon the shaft. To the pistons and yokes, at or near their point of intersection, are secured slides, which move along the outer surface of a circular guide to force and hold the pistons out, and along the inner or concave surface of an elliptical guide to force and hold the pistons in. Steel circular rings, working against the metallic packing in edge of the drum, are let into the heads of the cylinder, and are adjusted by set screws. The part of the cylinder above the points of intersection of the guides is recessed, to allow the exhaust steam to escape freely around the edge of the pistons as soon as they have completed their stroke. The steam is prevented from passing directly from one part to the other by a packing held against the drum by springs. To the shaft, at one end of the cylinder, is secured a cam, which moves a bar downward by striking against a pin and friction roller attached to the said bar. The bar is moved upward gradually, as allowed by the cam, by a spring, and is slotted to receive and slide upon a spindle and shafts, and to its upper part is attached a dog, which, as the said bar moves upward gradually, through suitable mechanism opens the valve suddenly at the beginning of the stroke. As the valve opens the valve steam is caught and locked

by a tappet. At the end of the stroke the valve will be instantly closed by the action of a stiff spring. To reverse the engine, the valve works are thrown out of gear, and the cut-off is thrown open by a lever. The engine, when reversed, works at full stroke, and is regulated by the throttle valve. The cut-off may also be made reversible by an extra cam, friction pulley, and lever arrangement.

220. Improved Crib.

The object of this invention is to provide an attachment to a crib, by means of which the same can be readily changed from the rocking position into a stationary one without being perceptible to the child sleeping therein, and permitting the quick and easy removal of the crib from one place to another. The invention consists of a slide attachment pivoted centrally to the rockers, made of two halves, having castors at their outer ends, by which the rocking crib can be changed directly into a crib moving on castors.

221. Improved Grain Sieve.

This invention relates to the construction of sieves for cleaning and separating grain, designed for all kinds of separating machines, and consists in a series of perforated angle plates so as to overlap each other, and bent up at their lower edges so as to form long narrow troughs, into which the grain is received, and whence it is discharged.

222. Improved Foot Power Apparatus.

This invention consists of a fly-wheel, foot treadle, and crank for obtaining motion, and a lever and connecting-rod for transmitting and converting the motion to work vertical saws, mortising machines, and the like, arranged in a simple and efficient way, calculated to provide driving mechanism for small shops, by which sawing, mortising, and the like, can be done to better advantage than with the ordinary hand-power machines.

223. Improved Lamp.

This invention is an improvement in the class of hanging or chandelier lamps provided with a detachable feeding reservoir; and the improvement relates to the construction of the suspending devices of the detachable reservoir, and the means for drawing off the settlings of the permanent reservoir.

224. Improved Ferry Bridge.

This invention consists of a bridge or platform for ferry boats arranged to swing down, without obstruction, as low as needed to be level with the boat deck at low water; and an incline in the bow of the boat to run under the projecting end of the bridge and raise it to the level of the boat deck, whether the water be high or low. The invention also consists of large V-shaped notches in the edge of the platform or bridge, and corresponding projections on the boat to enter them, and thus bring the boat and bridge into alignment. This part is more particularly designed for railroad ferry boats and bridges, to ensure the alignment of the tracks for running the cars from one to the other.

225. Improved Boot Heel Screw.

The object of this invention is to fasten boot heels made partly of wood and leather to the upper part of the boot heels by means of screw bolts, so that by unscrewing them the heels may be easily taken off and put on again, or new ones substituted in their stead. The screws may also be provided with sharp points, to be used in winter and by persons employed in occupations which require a firm hold of the feet, as raftsmen and others.

226. Improved Packing for Hydrants.

This invention consists in a hydrant packing ring, cylindrical on the inside and tapering downwardly on the outside, whereby leaking and waste of water or other liquid is effectually prevented.

227. Improved Manufacture of Friction Matches.

The object of this invention is to furnish to manufacturers of matches an improved dipping machine, by which the matches may be dipped more quickly and conveniently than with the machines hitherto in use; and also a more even and complete head of the matches be produced, and the workmen to a great extent protected against the deleterious influence of the phosphoric vapours. The invention consists of the combination of the receptacle for the phosphorus paste and surrounding water bath with stirrers and transferring rollers, together with regulating and guiding appliances.

228. Improved Weighing Attachment for Waggons.

This invention is intended to furnish an improved weighing attachment for waggons, to enable the load to be conveniently weighed without the necessity of driving to a platform scale, and which shall be so constructed that the knife edges will not be liable to wear while transporting the load. The bolsters are made in two parts, one attached to the axle, while the other or false part supports, and is moveable with the waggon box. The levers for lifting the box are pivoted to the fixed part of the bolster, and the weighing levers—which have for their fulcrum bars that are pivoted to the lifting levers—pass through slots in the fixed bolster, and converge and connect with the graduated arm of the beam or weighing lever, which has a fixed fulcrum beneath the box, and projects laterally through a slotted keeper.

229. Improved Pessary.

The object of this invention is to so improve the arrangement and connection of uterine repositors with their pendent shaft that any desired repositor suitable to the special position of the uterus may be applied, relieving thereby any undue pressure on the same and protecting against irritation and ulceration. The invention consists in the improvement of pessaries by providing the adjustable stem with a ring jointed to the support at one point only.

230. Improved Fence Post.

This invention consists of a fence post having its upper part of iron, its lower of iron, wood, and cement, or artificial stone, and provided with an intermediate cap. By means of the iron clasps the entire strength of the wooden rail is secured, while splinting by ordinary use is rendered impossible.

231. Improved Window Sash Ventilator.

This invention has for its object to furnish an improved device for ventilating rooms, cars, &c. through the sashes of the window. In the bottom of a window sash is formed a longitudinal slot, which is covered upon the inner side by a plate. The upper part of the sash bar is cut away adjacent to the plate so as to form an upward opening into the room, which opening may be surrounded by a box attached to the plate. A metallic plate is hinged at its upper edge to the sash bar or to a light metallic frame attached to said sash bar and surrounding the opening through it. The ends of the hinged plate are flanged or bent inward, and the said plate is made of such a size as to shut and fit closely into the opening through said sash bar. To the middle part of the inner side of the hinged plate is pivoted a long nut, into which screws a screw, swiveled to the plate, and having a knob formed upon its end for convenience in operating it. A fine wire gauze placed in the opening of the ventilator prevents the dust from entering the room, while allowing the air to pass in freely.

232. Improved Current Wheel.

This invention consists of a pair of boats arranged at some distance apart, connected by framework and supporting a couple of revolving drums between them, whereon endless chains with a series of buckets work, one of the drums being provided with tackle for swinging it up and down, and having deflectors connected with it to vary the influence of the water on the buckets according to the power required. The other drum, which is in stationary bearings, gears with a vertical drum, which is to transmit the power by a belt, and is as long as the extreme distance between high and low water, to allow the boats to rise and fall and yet work the driving belt properly.

233. Improved Hub Boring Machine.

The wheel for centreing and holding the waggon wheel, the hub of which is to be bored, is mounted so as to revolve in a vertical plane, and has a large central hole for the hub, also radial arms, to which the rim is to be clipped by holders, so as to hold the hub in the hole. The small end of the hub projects through the wheel to the right, and extends between sliding centreing jaws, which are drawn up against its sides by a right and left screw, so as to line the hub with the boring mandrel before it is fastened to the arms by the clips. Two opposite sides of the wheel are first adjusted and fastened, then the wheel is turned a quarter of a revolution, and the intermediate two points are adjusted and fastened. The jaws are mounted on a frame, and may be adjusted to hubs of different lengths. The boring mandrel is mounted on a carriage, which slides toward and from the wheel on ways, being moved by a hand crank shaft. It is revolved by a belt worked by a long drum on the driving shaft, which allows the belt to run along with the mandrel as it moves forward and backward. The cutters are alternately reversed, as shown, to cut on opposite sides of the mandrel, to divide and balance the pressure.

234. Improved Cooking Stove.

This invention is an improved cooking stove, which is so constructed that all the heat may be thrown to the top of the stove and directed to one or more of the boiler holes, as desired, to enable cooking to be done without heating the lower part of the stove; or all the heat may be made to pass around the oven, to enable the baking to be done without heating the upper part of the stove; or the heat may be made to circulate through both the upper and lower parts of the stove before escaping into the chimney, or may be made to pass directly into the chimney without heating either the upper or lower part, thus enabling the fuel to be used with great economy, and the room to be kept comparatively cool when desired, it being necessary to use no more fuel than the special purpose may require.

235. Improved Compound for Destroying Insects, &c.

The object of this invention is to furnish a compound for the destruction of the "borer," and other worms, grubs, and insects, which prey upon fruit and other trees; and it consists in a liquid or semi-liquid compound, composed of pine tar, soft soap, tobacco juice, and strong alkali. These ingredients are boiled together, and unslaked lime and strong dry ashes added. When all are stirred together, oil of tansy is put in. The compound is applied to the body of the tree, both above and below the surface of the ground, after excavating the earth and scraping the loose bark from the tree. A single coat of the compound applied with a common paint brush is sufficient to protect the tree for one year.

236. Improved Fly Trap.

The object of this invention is to furnish an effective and simple fly trap, by which the flies are caught rapidly and killed easily therein. The invention consists in the arrangement of an upper cage with cones for the entering of the flies, which cage is connected to a lower chamber with one cone leading into the upper cage, forming a double-acting trap. When the cage is filled with flies, the upper part is dipped into hot water, and the flies are then emptied out on taking off a cover. By detaching the cage from the lower chamber, the bait may easily be put into the lower chamber and through the top into the upper cones.

237. Improved Feed-Water Heater and Purifier.

This invention consists in separating the reservoir by a diagonal plate into two parts, of which one retains the water until the sediment is precipitated, and then allows it to flow over the other from the surface.

238. Improved Flooring Clamp.

This invention has for its object to furnish an improved clamp for forcing and holding jointed or matched work. In a lever about four or five feet long and of such a size as to give it the requisite strength is formed a slot to receive the tongue or tenon of a block, secured in place by a pin. The block is placed transversely upon the lever, and upon its forward side is formed a tongue to fit upon the edge of the boards. An iron bar bent twice nearly at right angles has a screw thread cut upon each end, and one extremity is passed through a hole in the lower end of the lever at right angles with the plane of the slot in the said lever, where it is secured in place. Upon the other end of the bar is screwed a nut having a flange formed upon each of its four sides, the first flange being flush with the inner surface of the said nut, and each successive flange being set back about half an inch farther than the next preceding one. Upon the rear side of the bar, at or near its lower end, is formed an arm projecting outward and upward. The outer end of the arm is made pointed, and to it is attached a brace, the other end of which is connected with the bar. To the bar at the side of the lever is attached a flange which has a curved slot formed in its upper part to receive a pin attached to the lever, to limit the movement of the bar and prevent it from falling over back when being adjusted to the work. In using the clamp, the flanged nut is adjusted upon the end of the bar, according to the thickness of the joist, so that a flange of the said nut may rest against the outer side of said joist, and the point of the arm against its other side. The face of the block is then adjusted upon the edge of the board, and the lever is operated, forcing the board to its place, and holding it there until nailed.

239. Improved Street Lamp.

This invention relates to means for securing the glass cover to lamps, and particularly street lamps, so that it may be comparatively inexpensive, securely held, and easily detached. It consists in a novel mode of locking the lamp seat to its holder; in peculiar means for preventing the seat from lurching forward; and, finally, in a new device by which the cap may be slid up and down in the socket and held off or on the glass with equal facility.

240. Improved Water Regulator and Cut-off.

This invention consists in improving water cut-offs, by combining with the main valve, that operates the waste valve, a hand mechanism by which both may be simultaneously operated from any part of a building.

241. Improved Hay and Cotton Press.

This invention relates to presses for reducing the bulk of cotton and allowing it to be baled into convenient form for transportation. It consists in a novel mode of attaching the sides of the press box so that they can be speedily thrown down from the cotton after compression, and allow its convenient manipulation. Also in a new mode of connecting the follower with its superposed lever so that it can readily be turned up out of the way when the cotton is being filled into the press box. Also in a peculiar mode of combining levers to cause two followers to clamp and press the cotton between them as if in a vice.

242. Improved Fence.

This invention consists in a peculiarly constructed metallic post support; in anchors thrown out on each side of the post support to steady the same and cause it to preserve its exact position; in a post formed of pieces that can be cheaply and quickly made from inexpensive timber; in a paling fence of a novel and economical construction; and in a peculiar method of preparing the lumber so that it can be conveniently packed for transportation, easily put together to form a fence, and withal so that great saving in the cost of a fence is attained.

243. Improved Lathe Chuck.

The shell is cast in a single piece, and to it are attached three worm wheels, which are made to revolve on their respective arbors at equal distance from the centre of the chuck of the lathe and from each other. These wheels are confined to the shell by plates which revolve with them; and on each is an arm which projects out over the chuck, to which the holding jaws are attached. The jaws are grooved to fit the arm; but when they are turned round on the arm to a certain position, they can be removed from the holding pin at will. When the worm wheels are turned, the jaws, when thus attached to the arms, will be carried toward or from the axis of the lathe, as may be desired. These wheels are revolved by means of a worm screw which is made to engage with the worm wheels—two wheels upon one side of the screw and one upon the other. This screw is turned by means of a wrench.

244. Improved Cotton Seed Planter.

The size of the discharge opening in the seed hopper is regulated to regulate the quantity of seed dropped by slides which work in guides attached to the bottom of

the hopper, and are secured in place, when adjusted, by set screws. The conductor spout is made long and narrow, and is secured beneath the discharge opening. Sweeps overlap the upper part of the opener plow and are designed to push back the clods and top soil, leaving the furrow of a uniform depth. They can be adjusted higher or lower, to enable the seeds to be planted deeper or shallower in the ground, as may be desired. The face of the drive wheel has a deep and wide V-shaped groove formed in it, so that it may press the side of the furrow inward to cover the seed without packing it upon said seed. With the wheel is connected gearing which moves the shaft within the hopper, to which are attached radial arms, which, as the said shaft is revolved, keep the cotton seeds stirred up so they cannot clog, and will pass readily to the discharge opening. Two flat arms, set at an angle with the axis of the said shaft, are inclined in such directions as to push the seed from the sides towards the centre of the hopper, so that they may more readily pass out through the discharge opening. With the drive wheel is connected other gearing communicating with another shaft that passes through the conductor spout. To the shaft are attached two circles of radial arms, at such a distance apart that the arms rigidly attached to the front and rear edges of the spout may pass between them. By this device the seeds, as they pass through the spout, will be separated from their fibres, or said fibres will be torn apart, so that the seeds will be deposited in the furrow uniformly and not in clumps or clusters.

245. Improved Cotton Press.

The follower which works upward in a vertical case has two arms jointed at one end to the lower side, one near each end, which, at the other end, have rollers to roll forward and backward on the bed frame. A rope is attached to the follower at one end, and is so led and arranged with suitable mechanism, that a drum being turned one way will force the follower up into the press case by moving the arms toward each other, so as to cause them to rise up erect, or nearly so; and said drum being turned the other way will allow said arms to roll back at the lower ends, return to the horizontal line, or nearly, and let the follower down again.

246. Method of forming Hollow Cores for Castings.

This invention consists in combining, with wax or other suitable mold, an elastic, inflatable and collapsible tube provided with connections by which it may be filled with air, emptied thereof, or closed air-tight.

247. Improved Bridge Truss.

The construction of this truss cannot be intelligibly described without the aid of a drawing. It allows, however, the braces and counter braces to be made shorter, thus increasing their strength and decreasing the weight of the bridge. The centres are upon the longer lines, which gives points of support to these long lines whenever they are subject to compression, thus materially increasing their resisting power to deflecting strains and strains of torsion. The mass of the iron, also, is thrown toward the top beam, thus allowing a liberal use of wrought iron in place of cast iron.

248. Improved Feeding Elevator for Corn Shellers.

To dispense with a second hand or "feeder" for these machines is the object of this invention; and it consists in an elevating chain, constructed as described. The chain is composed of wire links and plate links connected together. A portion of the plate links are made elevating links, one end of the plate of which this link is formed being turned outward at right angles and divided and spread. Pulleys are attached, one to the machine and the other to the box, the former being revolved by the motion of the machine which carries the elevator. As the belt is revolved, the ears of corn will be picked up, one by one, and carried to the hopper of the machine.

249. Improved Tyre Upsetting Machine.

The object of this invention is to furnish a tyre shrinker, which accomplishes, by its powerful action, the tightening or shrinking of tyres, with less time and labour than similar devices hitherto in use. The invention consists in the construction and arrangement of a sliding plate operated by an eccentric lever and a stationary plate carrying fixed blocks, and pivoted segmental blocks operated by a suitable mechanism. The turning of a disc to one side presses the segmental blocks against other blocks, so that the tyre can be firmly clamped between the rough uneven surfaces of these blocks. The reversing of the disc releases the tyre. When the tyre is firmly clamped, the forward or backward motion of the lever carries the sliding plate toward or away from the stationary plate, so that the shrinking or loosening of the tyre in a slow and powerful manner is obtained.

250. Improved Car Coupling.

This invention consists in a peculiar construction of the inner chamber of the drawhead, whereby the link is not only guided but maintained in its true and nearly horizontal position; in a device by which the coupling plate may be lifted by the brakesman without leaving the car, or stooping over so as to endanger his safety and run the risk of being precipitated between the cars; in a simple, novel, and effective means for enabling the cars to remain uncoupled during the making up of a train; in making a car-coupling link in two parts which are pivoted so that one can turn upon the other, and so that the two will separate as soon as a car has gone off the track; and finally, in the lock employed for connecting these two parts of coupling link detachably together.

251. Improved Method of Casting Water-Traps.

This invention consists in the improvement of stench traps, by locating a reinforcement at and on the inside of the bend. This becomes absolutely necessary in their construction because of the common practice that prevails of thrusting sticks or metallic rods down the pipes to relieve them of any obstacle that has lodged therein.

252. Improved Wood-Grinding Machine for Making Pulp.

This improved wood-grinding machine consists of a large flat horizontal stone disc fixed stationary on the frame, with a bevel face inclining toward the axis above the stone, around which the wood is caused to revolve in boxes operated by arms projecting from a rotating shaft above the stone. The boxes contain springs, which press the wood on to the face of the stone. The arms are jointed to lower the boxes from time to time as the face of the stone wears away. The joints are clamped fast after adjusting them to make the arms rigid to hold the boxes off the stone. Water is discharged upon the face of the stone by tubes from a hollow penstock projecting up through the centre, and connected by a pipe below with any suitable supply.

253. Improved Steering Apparatus.

A casing is placed upon and attached to the deck, having a top. A bracket is rigidly attached to the top, the end of which supports the point of the wheel shaft. A bevel pinion on the wheel shaft meshes into the bevel wheel of the vertical shaft. The upper end of this shaft is supported by a bracket. Its lower end revolves in a box in the lower part of the casing. There is a spur pinion on the vertical shaft which engages with horizontal rack bars which receive an alternate horizontal motion as the pinion is turned in either direction. These rack bars slide in grooves in the casing and are confined by the top. A yoke is rigidly attached to the top of the rudder post, and its top are slots or grooves. Swivel blocks on the ends of the rack bars rest in the grooves. The swivel pins allow the yoke to vibrate without binding, while the blocks have a slight movement in the slots. It will be seen that the movement of the steering wheel is instantly imparted to the rudder.

254. Improved Waggon Jack.

This invention relates to the construction of jacks for raising carriages and waggons. The stand consists of two plates separated by a longitudinal strip, a base block, and another block, all of which are about the thickness of the lifting bar and lever, but which allow the lifting bar and lever free play between the plates. The lifting bar is provided with a slot, in which slot is a stationary pin for limiting its vertical motion. The bar is confined between the plates. The lower end of the bar is cut on a circle, so that the end of the lever will always lift without binding it or causing undue friction. The lever is provided with a series of ratchet notches and a pawl. The pawl holds the lever and lifting bar in position when the latter is loaded. When the pawl is removed the long end of the lever will rise, and the liftng bar will drop by its own gravity. Friction rolls prevent friction against the edges of the lifting bar.

255. Improved Pole for Vehicles.

The inner ends of the two parts of the bar are screwed into a short rod or double nut. Upon the outer ends of the parts are screwed ornamental knobs. Upon each of the parts of the rod is placed a sleeve, upon the upper side of which is formed a slot to receive a tongue formed upon the upper side of the parts, so that the sleeves may be free to slide along longitudinally, but cannot turn. The outward movement of the sleeve is stopped by a knob, and its inward movement is limited by a collar. To the lower side of each of the sleeves is swivelled a bow, the ends of which are secured to the harness saddle by the screws that secure the saddle tree and pad to each other. To the upper side of the sleeves are attached short bars, to the ends of which are attached rings to receive the reins. To the centre of the bars is attached an ornamental device which may be so formed as to receive and hold the check rein. In case it is desired to use the bar with a single horse, the part to be used is unscrewed from the double nut, and the knob from the outer end of the other part is screwed upon it, thus forming a neat single-bar.

256. Improved Machine for Making Basket Splints.

This invention consists in making basket or chair splints of bark, and also in certain means for making them either of the fibre or the bark. The forward end of the feed table, upon which the slab is placed to be sawn into bolts, is slotted to pass between the cutters so that the said cutters may come close to the feed roller. The journals of the feed roller revolve in curved slots in the plates, and the said roller is held down to its work by springs, so that the roller may accommodate itself to the varying thickness of the slabs. The cutters revolve in water in a trough placed upon the table, from which the water may be withdrawn, through a hole in its bottom, to remove the sawdust. This arrangement keeps the cutters from becoming covered with gum. To the end of the shaft which is geared to the feed roller is attached a crank wheel, which may be made large and heavy to adapt it to serve as a fly wheel. To the crank pin of the wheel is pivoted the end of the connecting rod, to the other end of which is pivoted the clasp that holds the end of the knife or saw. The cutter is made with teeth when hard wood is to be operated upon, and with a sharp edge when bark or soft wood is to be worked. Against the forward edge of the end parts of the cutter rest plates, upon one end of which are formed beveled toes to rest under the beveled edge of the edged cutter to prevent the cutter from springing down. When the toothed cutter is to be used, the plates are turned end for end. The cutter is held down to its place by bearing plates which can be adjusted as required. A plate is attached to the feed table to adjust the thickness of the splints cut from the bolts by the cutter.

257. Improved Fireplace.

This invention consists in adjusting the hinged upper portion of the back of the grate by means of a screw rod and swiveled nut, and in the construction of the grate proper with a revolving bottom section in connection with two fixed side sections.

258. Improved Rotary Churn.

The body of the churn is provided with a closely fitting cover, to the lower side of which, upon the opposite sides of its centre, are attached wings or stationary dashers. These wings are made curved upon the side against which the milk dashes.

259. Improved Picture Hangers.

The picture frame has a web attached to it at two points, one being below the centre of the frame or picture, and the other near the top. The web, similar to suspender webbing, is doubled at one or both points where it is attached to the frame; but to outer portion a ring is attached, with which the suspending cord is connected. The use of the slide is to vary the inclination of the picture or frame. By moving the slide upward, the web is shortened, and the frame is brought nearer to an upright position; and when the slide is moved down the effect is contrary.

260. Improved Candlestick.

This invention consists in arranging the socket of the candlestick for different sizes of candles, by making it in two pieces connected by a slotted band spring.

261. Improved Metallic Lathing.

The object of this invention is to furnish an improved metallic sheathing for the inner walls of buildings. The ceiling and side walls of a building may be covered with sheets of cheap metal, having stamped, cast, or otherwise connected to its face dovetail shaped studs. The studs are in the shape of truncated pyramids, with face recesses for the firm adhesion of the plaster to be placed around and over them. These sheets are to be nailed or otherwise secured to the wall. Much less plaster is required for filling the space between the studs than for covering the ordinary lathed wall, and the work is performed in less time, while the plaster dries quicker, and is not so liable to crack.

262. Axle Box and Sleeve for Vehicle Wheel.

In this invention the axle is made of wood and the skein is fitted to the axle in the usual manner. There is a nut on the outer end of the skein and the sleeve is made of sheet metal and fitted on to the axle over the skein. A recess opens in this sleeve for the retention of the lubricating material. The interior of the pipe box is chambered out for containing the lubricating material, and the box is cast on a chill, to render it hard and durable. The sleeve may be made of sheet steel or composition metal, and not being confined, except by a lug or other device, to prevent its revolving with the wheel, it may be turned, when worn, upon one side, thus presenting a new surface for the bearing.

263. Improved Portable Steam Engine.

This invention consists in the improvement of the heaters of portable engines. The pump is arranged in a vertical position on one side of the boiler near the smoke pipe, attaching it to a vertical supporting plate having a concave side, fitting the boiler and bolted to it; also having a bearing at the upper end for a countershaft for driving the pump, said shaft extending across the top of the boilers, in front of the smoke pipe, to a bearing on the other side, where it carries a pulley for turning it by a belt from the crank shaft at the front end of the boiler. The plate is detachably connected to the boiler, so that it can be taken off readily for shipping. The portion of the shaft having the crank for driving the pump connects with the other portion by a clutch which is shifted by a lever, so that the pump can be worked or not, at will This arrangement is claimed to afford a simple, compact, and reliable connection of the pump in a portable engine, so that it can be stopped without stopping the engine whenever it may be required to do so, which often happens, and causes considerable unnecessary delay in all portable engines having the pump directly connected to the cross head in the ordinary way. Moreover, it saves the unnecessary loss of power expended in running the pump when it is not required.

264. Improved Mallet.

The object of this invention is to furnish a durable rawhide mallet for the use of machinists and others in putting together, taking apart, fixing, or adjusting metallic or wooden machinery, and for all similar purposes. It consists in a mallet with one or more rawhide heads secured in a metallic socket, which is made of metal in one solid piece. The handle is secured in the socket in the ordinary manner. The socket or body has a recess at one or both ends which receives the heads. These heads are made of rawhide coiled up and dried, and then turned to the desired size and shape and secured by means of a screw inside the socket.

265. Apparatus for Preserving Beer on Draught.

This invention relates to means for introducing air into casks to take the place of the liquid drawn out; and it consists in the combination, with a flexible bag or air holder, of a valve and bellows mechanism of a novel construction. Into the bung hole of a cask containing beer or other liquid that would be injured by contact with air is fitted a hollow bung having a nozzle formed upon its inner end, to which is secured the mouth of the bag, made of rubber or other suitable material, and of suffi-

cient size and elasticity to fill the cask when expanded. By this construction, as the liquid is drawn out of the cask, the air will enter the bag through the hollow bung, and expand said bag to take the place of the liquid drawn out.

266. Improved Extension Table.

This invention consists in extension rails, hinged to the rails of the side table, and to extension legs. These extension rails are each made in two pieces, connected together by pivoted strips on the bottom and top of the rails. When the rails are extended, they are held in position by means of knob buttons. These buttons are attached to one part, and turn on a central pivot over on to the other part, thus holding the two pieces parallel with the rails of the side table. The cover of the table is in two parts, hinged together like ordinary card tables. When the extension rail is drawn out, the half of the table top is turned over on to it, thus making a square table. When the extension rails are folded, they are in a position with the half of the top turned back and resting on the other part of the top. There is a spring catch on the bottom of the drawer frame which engages with a lip on the side rail which holds the parts securely together. When the table is extended, the rails of the four sides present a uniform and finished appearance.

267. Improved Corn Planter.

In this invention the seed hoppers are attached to the frame of the machine. The ends of the dropping slide enter the lower parts of the hopper through holes in their inner sides. A spring has its upper end attached to a cross bar of the frame, and its lower end enters a hole in the dropping slide, to bring said slide back to its position when released from the device that moves it. To the slide, toward one end, is pivoted the end of a connecting rod, the other end of which is bent at right angles, passing through a short curved slot in a wheel or disc, and is secured in place by a nut or other convenient means. The wheel or disc is attached to the end of a short shaft which revolves in bearings attached to a cross bar of the frame, and to its other end is attached a bevel gear wheel, the teeth of which mesh into the teeth of a similar wheel attached to the axle, which revolves in bearings attached to the frame, and to its ends are rigidly attached wheels, so that the said wheels may carry the said axle with them in their revolution. In each end of the axle, at a little distance from the wheels, is formed a universal joint, so that the said wheels may accommodate themselves to the surface of the ground, however uneven said surface may be. A further use of the joint is to enable the wheels to be lifted by levers and rods when the machine is to be turned about, or the discharge of seed requires to be arrested.

268. Improved Door Fastener.

This invention consists in supplying a semi-circular bar to a door and arranging a weighted lever to engage therewith (the bar being notched or perforated for the purpose), so that the door may be locked in any position, shut, open, or partly open. The contrivance is designed more particularly for stable, carriage-house, barn and shop doors; but it is alike applicable for doors of dwelling-houses.

269. Improved Steam Generator.

This invention consists of secondary return flues, arranged in the masonry along the sides of the boiler, above the furnace, into which the heat is turned at the front of the boiler, instead of discharging into the smoke stack, thus economizing the heat by causing it to pass along the boiler once more than in other arrangements.

270. Improved Fireproof Shutter.

This invention consists of a door or shutter composed of three plates of metal united together side by side, the two outer sheets being plain, and the middle one being bent in zigzag or other form, so as to form channels or spaces between it and the outer sheets for the circulation of air or water, to cool the door or shutter in case it is exposed to fire, and prevent the transmission of heat through the door.

271. Improved Earth-Boring Machine.

In this invention the square auger shaft has a screw point fixed in it permanently. The lower part of the screw auger is fitted so as to be adjusted relatively to the point, to use said point with it or not, and will have a set screw to fasten it where it is required to be. The upper part of the screw auger is arranged to slide up and down freely, and rests on the lower part when boring. By the bar or plate in which it is fitted to turn freely and in which it is confined by the collar, this part of the auger is connected to cords which pass over pulleys under the platform to a drum, which is fitted loosely on the crank shaft, and clutches with it to be turned by it for elevating the borings when moved to the right by a lever, so that studs will engage, and it disengages them and lets the auger fall again when the lever is moved the other way. This shaft is the same one that is employed to turn the shaft for boring, and is itself turned by a shaft, pinion, and wheel. The driving power is applied to the shaft by a belt from a steam-engine, horse, or other power, or it may be turned by hand.

272. Improved Mould or Box for Brick Press.

The press boxes for making fire-brick have heretofore been cast solid and lined with steel. The steel facing soon wears away, so that the bricks are too large and untrue. The steel has then to be taken out and replaced with new, which can only be done at considerable expense. The object of this invention is to furnish a mould which shall obviate the difficulties experienced in the use of the usual press-box.

273. Improved Plough Coupling.

The invention has for its object to furnish an improved coupling for connecting two ploughs, to enable them to be guided and controlled by one man; and it consists in the bent bars strengthened at their bends by extra rods, provided at their lower ends with swiveled clamping plates and set screws, and at their upper ends with eyes, slides, and notches to receive the key.

274. Improved Flux or Smelting Ore.

In this invention is produced, by a calcining process, from fluorspar, an improved flux for iron ore; and by a similar treatment of lead ores, mixed with fluorspar, the rapid separation of the calcined spar from the lead ores. In its natural state fluorspar is detrimental to the hearths of iron furnaces. The fluorspar, however, which is treated by the calcining process described, forms a superior flux for iron ore without destroying the brick lining of the furnaces. The calcined spar, when produced from the lead ore with which it is formed, is turned thereby to satisfactory use in the arts, while the calcining process at the same time, by melting the minute particles of lead which are carried off by the old processes, increases the yield of the ore. The ore is also desulphurized, and the carrying off of particles of lead through the chimney prevented for the same reason, so that a greater percentage of lead is produced from the ore.

275. Improved Chuck.

It is a well-known experience in casehardening jaws that the relative positions of the metallic particles change more or less, so that it is almost impossible to hold work and get it perfectly true. To overcome this difficulty the inventor has introduced on the face of the jaw a raised seat, together with a groove between the face and bite of the jaw, rounding off thereby the corner, and allowing the use of a Tanite or vitrified emery wheel, by which the raised seat may be ground perfectly true. On the face part of each jaw on which the work rests for turning is introduced a raised seat of suitable size, together with a groove or recess formed in the corner of the bite and face of the saw, removing and rounding off the same. The groove admits the use of an emery wheel for grinding off the raised part, so that work coming to a sharp corner will rest upon the ground seat and the bite of the jaw only, and assume a perfectly true position thereon, as an equal pressure is exerted on the same. Another advantage of the groove is that a grinding wheel without a perfect corner can do its work accurately, as it projects beyond the raised part into the recess formed by the groove, grinding the seat perfectly without fracture at the edges.

276. Improved Log Turner.

In this invention the forward part of the log deck is made inclined, so that when a log is rolled past its centre it may roll directly upon the carriage, where it is stopped in proper position by the standards in the head block. A wheel or segment of a wheel has an axle which works in short guide slots in the middle part of the log deck. The wheel is preferably in the form of a half wheel or semi-circle, and an axle is arranged in such a position that the straight side of the said wheel or segment, when turned into the horizontal position, may be a little below the top line of the log deck, so as to be out of the way of the logs when rolled upon the said deck.

277. Improved Steam Engine Governor.

In this invention a pipe conducts the steam from the boiler, and is connected with a chamber. The valve and seat are made of metal suitable for the purpose. The cylinder has a flange which fits steam-tight into the base flange of the chamber. The cylinder is closed at the top and fits inside the valve. The steam presses equally on each side of the valve, so that it is balanced, and has free motion to regulate the speed of the engine. The top part of the shell of the chamber fits into the upright bow, so that the latter can be turned to give the driving shaft any required direction.

278. Improved Hydraulic Motor.

This invention consists in the application of the stream or body of water to a vertical cistern and cistern valve, which is balanced by a weighted lever, so that on floating, the water rushes into a horizontal pipe and trough filled with water. The forward motion of the water, in connection with the closing of the cistern valve, produces a forward motion of a piston valve at closed end of horizontal pipe, which is connected to the machinery to be driven by it. Both the lever power and piston power may be utilized as desired—the lever power for crushing quartz and stamping bones, the latter, by suitable transmission, for driving different machines.

279. Improved Spring Bottom.

In this invention, three bottom rails, preferably, are employed in one bed. The top slats are placed transversely upon three rows of springs that stand on the rails. Each slat is mortised near the end to receive a loop from each spring beneath, except from the middle springs, which have loops that wrap around the slats. Straps are fastened to the head and foot pieces of the bed bottom, and pass through the loops of the side row of springs and over the slats, so that the said straps will serve to prevent the loops from being drawn down through the mortises of the slats. These several clasps form holders by which the springs will be evenly held upon the lower rails, and are a very convenient and practical mode of attachment for the springs, allowing them ready application and removal.

280. Adjustable Treadle for Sewing Machines.

This invention consists of an arrangement of the treadle pivot rod, in curved slots in the end frames or other supports, for adjusting the treadle toward or from the front of the machine to suit the operator; the slots are curved to the axis of the crank shaft, so that the distance between the rod and the centre remains the same. It is applicable to the table of a sewing machine, lathe, or any other machine to be worked by foot power.

281. Improved Drill Rod Coupling.

This invention consists of one section, having a screw-threaded portion at the end of smaller size than the rod screwing into a socket in the end of the other section by a right-hand screw, and a sleeve screwing on the two sections by a left-hand thread down against a collar on the lower section, by which the joints are locked so that they cannot work loose.

282. Improved Device for Dressing Saw Teeth.

This invention consists in a slotted clamp, provided with recesses to receive the saw, to which it is secured by clamp screws, and an anvil, which is placed under a saw tooth, and clamped in place against the same by a wedge pin. The anvil is placed directly under the inner side of the saw tooth, so that the same rests fully thereon; then the set screws are firmly applied to the saw, so that the tooth can be forged or dressed to the width and thickness required.

283. Improved Grain Dryer.

The preparation of grain for grinding by toughening the husk or bran has hitherto been done by moistening the grain and then heating the same, the main object being the damping of the bran and keeping dry the inside of the grain. The drying the grain after moistening does not only take longer time, but has also a softening influence on the interior, which is to be avoided, while by heating the grain first and damping it afterward, the husk will toughen in less time and the inside part of the grain remain perfectly dry. This apparatus is constructed on this principle, and consists of a series of tubes which pass the grain through the heating chamber into the steam chamber. The ends of the tubes which enter the steam chamber are perforated to facilitate the moistening process. By means of different steam chambers and increased admission of steam, husks of different texture may be prepared and passed through at the same time.

284. Improved Tree Protector.

This invention consists in providing the metal slats composing the protector with sharp downwardly projecting spurs. The protector, placed around the tree, is composed of upright sheet metal slats which are connected by wire bands, so as to be held together around the tree. The lower part may be bent outwardly to rest on the ground. The slats may be made of any suitable material, preferably of sheet iron, and are covered with coal-tar or other preservative against the influence of the weather. For still further protecting the trees against rabbits and other destructive animals, the slats may be provided with projecting parts or spurs placed at convenient heights.

285. Improved Fruit Crate.

In this invention staves or slats are placed a suitable distance from each other, according to the use for which the crate is intended, and in number according to the size or diameter desired. The heads may be two or more in number, according to the size and number of the compartments of the crate.

286. Improved Shingle Machine.

This invention consists of two reciprocating block-holding frames, which are alternately moved against a horizontal circular saw by means of the vertical saw shaft in gear connection with slotted lever arms. The blocks are properly set in frames by tilting platforms, as in other machines of this class, the same being operated by a pawl and ratchet mechanism in connection with a bent lever and spring arrangement for engaging and disengaging the blocks.

287. Improved Weeding Hoe.

This invention consists in a hoe with an inclined cutting edge, the object being to enable it to enter the ground more easily and to prevent dirt adhering to the blade underneath the eye.

288. Improved Harvester Rake.

This invention consists in a slide, toothed bar, slide rod, guide, rake head, rake bar, trip pin, two shafts, four gear wheels, and two segments of gear wheels, in combination with each other and with the frame, the platform, and the drive wheel of a harvester. By this construction, as the rake head begins to move inward to sweep a gavel from the platform, the guide enters a notch in the under side of the rake head, which allows the rake head to drop, so that its teeth may move along the platform and carry the grain with them. As the rake head begins its outward movement, the pin strikes the inclined inner end of the guide plate and moves its outer end forward, so that the slide attached to the rake head may slide along the said guide which raises the forward part of said rake head, so that it may pass back without its teeth coming in contact with the grain upon the platform.

289. Improved Micrometer Gauge.

This invention is intended for measuring articles in minute fractions, and with unusual accuracy. A frame supports upper and lower screws formed with threads, whose section shows an equilateral triangle, and which are reversed in their direction. A milled head or knob, swivelled on a screw, is fastened in the head of the upper

screw. A plain outer socket is rigidly attached to this screw, while the knob has a downward flange extending over the upper part of the socket. Between this part and the knob is a washer having a series of springs which produce within the three parts a frictional connection that will cause them to turn together until a resistance is met with adequate to overcome this friction. Packing rings are let into annular recesses of sockets to exclude dust. A numerical circular notation is made upon the movable socket and a linear notation on the stationary socket.

290. Improved Air Gas Machine.

This invention has for its object to furnish an improved apparatus for forcing air in uniform quantities into a carbureter. The invention consists in the combination of series of water sealed vessels, toothed uprights, segmental toothed gear wheels, shafts, inlet pipes provided with valves at their inner ends, outlet pipes provided with valves at their outer ends, water sealed vessels, and discharge pipe with each other; and is an improvement on a device patented on July 23, 1872, to the same inventor and Henry Curliss.

291. Improved Seed Separator.

In this invention a hollow sheet metal cylinder has its interior surface studded with numerous small cells, too small for the grain, but large enough to admit the cockle and other small matters to be retained and carried above the grain, and thus separated from it. A stationary trough or receptacle extends through the cylinder from end to end, and is arranged with one edge close to the surface of the cylinder near about the centre vertically on the upwardly moving side, so that the matters contained in the small cells will be carried above it and then fall into it. A small perforated cylinder is arranged in the hollow sheet metal cylinder to receive the grain first and separate the large coarse matters The foul matters accumulating may be scraped out at one end from time to time.

292. Improved Tool Receptacle.

The object of this invention is to furnish, for the use of mechanics, artisans, and machinists, an improved die stand, into which the different dies for marking metal work are placed and protected against loss or accidental damage; and the device consists of a case of suitable material, surrounding a block with holes, corresponding to the number of dies, into which they are inserted through a perforated top, and inclosed therein by a revolving cover plate.

293. Improved Pruning Knife.

This invention consists in constructing the parts of a pruning knife in such a manner that it may be quickly and conveniently changed from a shrub to a tree pruner, or the reverse.

294. Improved Chain Clamp.

This consists in movable jaws provided with rectangular recesses across the upper corners and horizontal chain rest, the said jaws, when closed, leaving an intervening open space large enough for the downward passage of the rivet.

295. Improved Ventilator.

This is a frame in which a revolving ventilator is arranged so that the draught can be governed and light not be excluded. The device consists of four wings, two of glass and two of wire gauze, amounting to two planes set at right angles to each other. By a quarter revolution the glass will be thrown into a horizontal position, and the perforated pieces will take its place, thus admitting air while excluding insects.

296. Improved Farm Gate.

This invention is an improvement in the class of farm gates, wherein the lower part may be raised and lowered independently of the upper part. Two lower bars are pivoted at their rear ends to one of the gate standards or cross-bars. Their forward ends enter slots in the opposite cross-bar. To one of the upper horizontal bars is attached a latch and hook, the latter of which, when the lower bars are raised, catches their forward ends and holds them up.

297. Improved Milk and Cream Cooler.

The outer vessel of this cooler is provided with a spout upon its upper part for pouring in, and with a short pipe in its lower part for drawing off, the water. There is also an opening to allow the waste water to escape when a stream of running water is introduced into the spout. A ring flange is attached to the bottom of the outer vessel to support the inner vessel, so that there may be a water space between the bottoms, and has a number of holes to allow free circulation. To the outer vessel are pivoted hooks to keep the inner vessel in place when the water is poured in. The cover has ventilators to allow the air to circulate freely, the mouths of said ventilators being covered with wire gauze.

298. Improved Fluting Machine.

The first part of the invention consists of an arrangement of devices for adjusting the roller and regulating the pressure, whereby the roller which is raised to facilitate the adjusting of the goods can be raised without contracting the pressure springs. Less power is thus needed than is required to lift it against the springs. The second part consists of guides in connection with the roller to control it against lateral vibration. The third part consists in having the wheel by which motion is imparted to one of the rollers provided with and rigidly attached to a short shaft which couples with the roller, so that the latter can be removed without disturbing the wheel, and without the necessity of sliding the wheel off and on a portion of the roller.

299. Improved Steam Lubricator.

It is proposed to have a hollow globe holder for the oil, having a hollow standard, with a conical enlargement of the hollow space at the lower end. This end screws into a hollow stand on the steam chest or journal box. A stationary conical plug projects upward from the bottom of the socket into the hollow of the lower end of the standard, so as to regulate the flow of oil by closing the mouth of said standard more or less, as the holder and standard are screwed up or down. The holder has a notched ring around its middle, which is graduated and numbered to show the extent of the opening of the feed at the mouth of the standard, and a spring click engages it to hold the oil holder to any position in which it is set. From the socket below the standard of the holder the oil enters a little chamber, in the middle of which a tube rises around the passage from said chamber into the steam chest to retain a quantity of oil in said chamber. In feeding, the oil will flow from the surface of the body contained in said recess, on the top of the tube, and down the inner surface of it, while the steam rises up in the centre of the space. There is a valve which will screw into the proper passage and close it, so that the steam may be shut off at any time to allow of taking off the holder when it may be desired to do so.

300. Improved Breech-Loading Fire Arm.

This invention consists in a pivoted breech block, having a spring hook connected therewith and a cartridge extractor arranged centrally beneath the barrel, combined, to extract the old cartridges and throw them clear of the gun, as well as support the new one.

301. Improved Projectile.

This invention is more particularly an improvement on the projectile for which letters patent were issued to applicant October 4, 1870; and consists in providing the stem of the projectile with a double set of guide wings, one for preventing its rotation during flight, and the other for causing it to describe a curve of greater or less radius.

302. Improved Can Soldering Machine.

This invention consists in providing means for feeding cans to a soldering apparatus, and for reversing them so that both heads may be soldered to the body in rapid succession, and without the removal of the same from their holder.

303. Improved Ventilating Window Sash.

This invention relates to convenient modes of ventilating rooms through the windows without bringing to bear upon the persons therein a cold draught of air. The invention consists in a novel arrangement of a small supplementary sash to slide above the top and to the bottom sash.

304. Improved Rudder for Vessels.

This invention is an improvement in rudders of the hollow class, and consists in forming a balanced rudder of two parallel plates attached to transverse bars, which impart rigidity to said plates, and are in turn secured to the vertical shaft in such a manner as to leave a space between each of said plates and the shaft. The object is to increase the surface acted on by the water.

305. Improved Fence.

This invention relates to fences adapted to those parts of the country where stock farming is pursued, where timber is scarce, and where the object is to make a fence which will turn hogs as well as cattle and horses, at the same time being cheap, easily put up, and susceptible of quick and ready repair. It consists in posts, rails, and stakes, wired together so as to allow the lower parts to be filled with brush.

306. Furnace for Producing Wrought-Iron from Ore.

This invention consists in combining with a rotary puddling furnace a gas-producing furnace and a deoxidizing chamber, so that the waste gases may be conveniently applied to deoxidize and carbonize the ore preliminary to its reduction.

307. Improved Combined Wardrobe, Bedstead, Chair, and Table.

The front of the cabinet has narrow sides, constituting the pendent sides of the table top when detached from the case and arranged for the table. The folding legs are pivoted to it, being let down and fastened by buttons. Part of the top of the cabinet constitutes the back of the chair, and has the seat hinged to it. It also has an upholstered cushion above the seat; and this is so fitted on the back and connected to the seat that when it swings down against the side of the back to adjust the latter for its place in the cover, it draws the cushion down below the top to uncover the end sufficiently to rest on the top of the sideboard of the cabinet, and when the seat swings up into position it moves the cushion up to hide the back. The sides of the chair are formed of two boards, which nest together so as to be laid on the top of the cabinet and constitute the balance of the cover. The sections of the sides of the case, and boards between the front and the main part, comprise the principal portion of the bed or reclining couch. The wash-stand, with a towel rack attached, is mounted on a door, which is hinged to the side, where an opening is made in the side of the case into a chamber within, so that the stand swings into the case and is enclosed when the door is shut, and swings out for use when the door is opened. At the side opposite the one having the wash-stand, a drawer is arranged for linen and other like goods.

308. Improved Umbrella.

The inventor makes clips or laps for fastening to umbrella ribs, to pivot the braces to, by taking little strips of sheet metal, well coated with tin, and folding the ends over back on one side, enough to make the elevation of the folded part about half the thickness of the rib, and so that the space between the said folded part will be just enough to wrap around the brace and inclose it snugly when the folded parts meet on the inside of the rib. A projection is thus formed to which the branched end of the brace can be pivoted. These ends and the folds are united together, and also the lap to the rib, by a drop of solder.

309. Improved Wheel Plough.

This invention is a sulky attachment, which may be applied to the beam of an ordinary plough. The axle is bent in peculiar shape. One wheel works on a crank axle, which, by a suitable lever, may be adjusted so that the wheel may run in a furrow or on the surface and the machine still remain horizontal. The plough has a free lateral and vertical movement, easily governed by a lever at the hand of the driver.

310. Improved Machine for Turning Waggon Axles.

This invention consists of a novel arrangement of the tool carrier, pattern, and feed screw, in a machine in which the stick to be turned is stationary, and the cutter is revolved around and fed along the stick. The axle, the ends of which are to be turned, is laid on a bench between the posts, and centred by suitable means. A large short tube is bolted to the posts in the axis of the machine, so that the axle to be turned projects through it. A pulley revolves on this tube, and carries the face plate, in front of which, at a suitable distance, is another face plate, in four arms, arranged on the sleeve of the tail centre, and connected to the first face plate by a rod, feed screw, tool supporting rod, and the pattern rod or centres, all of which are arranged at equal distances apart around the axis, and at equal distances therefrom. The pattern is a facsimile of what is to be produced. It extends from the face plate to one of the arms, and is fixed on them so that it can revolve, making one revolution on its axis during each revolution which it makes around the axle. The tool holder consists of a freely moving bar, and it rests on the pattern. The cutter is attached to the bar on the side next to the pattern. The tool bar is moved along slowly in the direction of the axis of the axle, to carry the tool from one end to the other of the part to be turned. It is also proposed to utilize this machine for making oval tenons on spokes upon the same plan.

311. Improved Wood Filling.

This invention relates to a compound for filling wood previous to the application of a paint or varnish, and consists in a preparation which is entirely devoid of colour, and will not therefore change the characteristic hue of the wood, which can be applied with an equally favourable result to all varieties, and which permeates so thoroughly the pores and fills so completely the interstices between the fibres that a single coat of varnish or paint will be generally sufficient to produce the designed outside face upon the wood.

312. Improved Railroad Water Crane.

This invention consists in a frost-proof jet, above which is a hollow standard surmounted by a movable bent tube. Within the standard is the valve rod, to the lower part of which is attached the valve. The rod continues on down below the latter, and is encircled by a spring which forces the valve up against its seat. On the upper part of the valve rod is a rack, in which works a pinion, connecting by suitable mechanism with a hand wheel outside. By this means the valve is opened or shut.

313. Improved Harness Maker's Clamp.

This invention relates to apparatus for holding leather in the operation of sewing it for harness or shoe making or other purposes. The stand is wedge-shaped, and on each of the inclined sides of the wedge there is a rib. There is also a shoulder on each side equal to the thickness of the lower end of the jaws. The inner sides of the jaws are grooved for the ribs and fitted to the inclined sides of the wedge. The jaws are raised by pressing on a lever, and when raised are lowered and are spread apart by a spring. Vertical springs draw the jaws down and hold them in their normal position, which is to tightly clamp the leather. The jaws act as levers, and turn slightly on their fulcrum rods when raised or lowered.

314. Improved Spring Hinge.

This improvement consists in attaching a standard to one leaf of a hinge, and connecting a spring encircled extension thereof with the pintle of the hinge. On opening, the spring is compressed so that the action of the same on the door produces the shutting of the latter, securing also at the same time sufficient resistance against the accidental blowing open by the wind or otherwise.

315. Improved Portfolio Holder.

This invention relates to portfolio holders which are adapted to be fastened conveniently against the wall of a room and above the wash-board. It consists in the mode of combining the two side frames with the bottom support of the portfolio, so that the latter may be held closely locked and protected against unnecessary handling, while it may be also held at an oblique angle so as to be easily examined. It also consists in providing the portfolio supports with end guards which prevent withdrawal of the portfolio and are adjustable to those of different sizes.

316. Stop Mechanism for Doubling and Twisting Machines.

This invention consists of a stop motion in connection with the feeding or delivering roll of a twisting machine, so contrived that if the threads or yarns break it will stop the delivery, and thus prevent the ends from going from one spindle to another. The tension of the yarn holds the inner weighted end of a lever up above stud pins on the pulley of the delivery roll so long as the yarn remains taut and unbroken, but when the yarn breaks the inner end of the lever will fall and stop the delivery roll by engaging one of the stop pins, and thus prevent the further delivery of the yarn until it is mended.

317. Improved Machine for Rolling Round Tapered Bars.

The object in the present invention is to facilitate the manufacture of spindles and all articles of tapering form, and it consists of two eccentric discs revolving in opposite directions on a central arbour in a suitably constructed frame, so bevelled as to roll or straighten a tapering spindle or other article, and in one or more guides through which the article to be tapered is introduced. The eccentric surfaces have the effect of inclined planes upon the spindle, approaching each other in one part of their revolution, and receding from each other in another part, while the spindle simply revolves and receives its form and shape from the pressure imparted by the bevelled and eccentric revolving surfaces.

318. Improved Saw Tooth Gauge.

This invention relates to an ingenious apparatus for temporary attachment to the saw mandrel of a circular saw, to gauge the teeth round and as to the set; and consists, first, of improved means for attaching the sweep to the mandrel; second, a templet in combination with the sweep, to insure the parallelism of the sweep with the saw, and an arrangement of the tooth gauge supporting arm in the end of the sweep to shift laterally, as required, to adjust the gauges to the plane of the saw; third, an arrangement of the gauge holding arm to oscillate in the sweep, to adjust the gauge to the front face of the teeth; fourth, an adjustable gauge, with a scale so arranged on the aforesaid arm that the angle of the teeth front may be gauged by it with certainty (it is also arranged so as to gauge the teeth round); fifth, an adjustable gauge on the aforesaid arm for gauging the set of the teeth; and, sixth, an upsetting swage holder on the said arm.

319. Improved Compound Metal Working Machine.

The object of this invention is to furnish for the use of blacksmiths and waggon manufacturers a combination tool, by which the operations of cutting and punching iron, and the tightening, upsetting, and bending of tires may be accomplished in a single machine. The frame of the instrument, of oblong shape, is firmly secured to the ground, and provided with strong vertical standards, between which is pivoted an eccentric which is operated by a lever. The eccentric operates on the knee-joint levers, one of which is hinged at its outer end to a heavy block, moving in a recess of the frame. The block is pivoted with its lower end to frame, and provided with a cutting blade which acts on a similar blade of the frame in the manner of shears. The other knee-joint lever is hinged to a sliding carriage which moves in a recess, and to which is secured, in the direction of the longitudinal axis of frame, the puncher, which acts on a perforated steel cutter in a socket. The upper side of carriage is grooved and has a vertical extension plate which carries a strong bar or bolt and a partially grooved eccentric. Other eccentrics and grooved bases are arranged, between which and their corresponding grooved bases the waggon-tire is clamped and either tightened or upset when off the wheel, as required, by the lever acting on carriage. For bending or rolling the tire the cylindrical rollers are arranged sidewise of the frame. The outer rollers are adjustable for tires of different sizes and thicknesses. The notched roller is placed between and above the outer rollers and turned by a crank, giving the bend to the tire on its passage through them.

320. Improved Sheet Metal Roofing.

This invention consists in the employment of fine corrugations of the metallic sheets used in the construction of roofs, and for similar purposes, and the arrangement of the corrugations in the direction crosswise to the pitch of the roof, also crosswise to the length direction of the gutters, eaves troughs, &c. This fine corrugation may be made one eighth of an inch deep by half an inch in width, or in other proportions. It can be very fine and still allow by its curvings the expansion and contraction of the metallic sheet in the direction crosswise to the corrugation, and thus allow of the bending of the sheets transversely to the corrugation sufficiently to permit the use of the various modes of uniting the sheets of roofing now practised.

321. Improved Mode of Attaching Journals to Feed Rollers.

This invention consists in making shafts with ends flaring conically outward, around which the rollers are cast. Screws and nuts on the shaft just beside the rollers draw the journals tight into the holes of the former in case they become loose through any cause.

322. Improved Doubletree Equalizer.

This invention relates to doubletrees that are usually pivoted to the tongue of a vehicle or the end of a plough beam to allow a certain amount of vibratory movement. It consists in remedying the objectionable looseness on the beam or tongue and the want of a proper limitation of the motion of the said doubletree by extending rearwardly the place of the centre bolt, and placing in front a friction device which holds the doubletree steady until a greater force is applied at one end than the other, and which, at the same time, regulates the extent of its motion.

323. Improved Bridge.

This invention consists in a novel method of constructing the arches and chords of truss bridges by successive layers of planks nailed together, and at the extremities of banded and braced wedges.

324. Improved Adding Machine.

This invention consists in the use of concentric circles with partitions between them, turning upon a revolving plate, around a common centre; the circles are divided into two or more sections, and the sections into ten spaces each, and so arranged that when an inner circle is turned ten spaces, it turns the next outer circle one space, by means of a drop catch falling through a graded opening in the partition between them, from the outer circumference of the inner circle, and catching teeth arranged on the inner circumference of the circle. The teeth are so graded as to allow the drop, working loosely when down in the opening of the partition, to slide over them when the outer circle is turned backward.

325. Improved Car Coupling.

This invention consists in a spring-pressed lever in rear of drawhead, provided on one end with a foot piece by which the other end may be removed from over the link hook and allow it to rise; in a treadle and a grapple hook to hold the lever; in a grapple hook bar and trigger, so contrived that the latter lifts the former and allows a spring-pressed lever to turn back and lock the link hook; and finally in the combination of the essential parts so as to form an improved car coupling.

326. Improved Fruit and Egg Carrier.

The invention consists in an egg or fruit carrier made of a series of rows of cardboard pentagonal cells, having their bottoms held thereto by a U-shaped clamp and fitted in obtuse angled recesses on the inside of the end pieces of frame.

327. Improved Porter's Box.

This invention consists in a box for the use of porters in stores, warehouses and similar establishments, the object of which is to provide a convenient place for the tools and materials used by them in their work. It has apartments, a receptacle for nails, stencils, stencil brush, ink, &c., conveniently and compactly arranged.

328. Improved Steering Apparatus.

This invention relates to means by which rudders may be worked in steering ships, vessels, or boats, and consists in combining with the rudder a sprocket wheel, chain and reversely threaded screws rotating in opposite directions, also in connecting the sliding pinions with screws.

329. Improved Lemon Squeezer.

This invention has for its object to furnish an improved lemon squeezer, so constructed that a whole lemon may be put into it and the juice expressed without its being necessary to first cut the said lemon, and which will prevent the juice from squirting out over the operator. The invention consists in the knife secured in the cavity of a lemon squeezer; in the arrangement of the knife in the cavity of a lemon squeezer in an inclined position; in the slit or notch formed in the knob or projection, and in side flanges which overlap the side edges and thus prevent the juice from squirting out.

330. Improved Lamp.

This invention consists in the construction of a lamp in such manner as to interpose a body of water, or other incombustible fluid, between a small quantity of oil in contact with the wick and the main body of oil contained in a separate reservoir; also so as to supply the flame automatically with oil from said reservoir through the water to the wick; also, in certain cases, when a more complicated but safer lamp is desired, to isolate the oil contained in a suitable reservoir from all contact with any atmosphere whatever, thus preventing the possibility of ignition within the lamp.

331. Improved Combined Chair and Secretary.

The object of this invention is to furnish a convenient piece of furniture for family or business use, which combines the advantages of an arm-chair, secretary, writing table, drawers, &c., if used by a business man or invalid, with those of a work receptacle, scrap bag, needle and thread repository, &c., if used by a lady. The whole is portable and may be easily moved to any desired place. The invention consists mainly in combining an arm-chair with a case or secretary having movable pigeonhole arrangement, drawers, and folding leaves, with drawers under the seat of the chair, and castors on one side under the secretary to be lifted by the arms of the chair and rolled about.

332. Improved Coal Breaker.

This invention consists in casting teeth on both sides of the rack plate composing the cylindrical breaker, so that the plate, when the teeth on one side are worn, can be reversed and used on the other side.

333. Improved Harvester Reel.

This invention has for its object to furnish an improved harvester reel, which shall be so constructed that the driver may conveniently adjust the reel bars so as to bring leaning grain upon the platform. The invention consists in the reel shaft, made in two parts, provided with grooved and recessed flanged collars at their inner ends. The reel shaft is made in two parts, having flanged collars formed upon their inner or adjacent ends, the flanges of which are securely bolted to each other. In the adjacent faces of the flanges are the reel arms, which are bent inward at right angles, so as to enter a small disc placed in a cavity formed to receive it in the central parts of the flanged collars, which cavity is made larger than the disc, so that the said disc may be moved longitudinally in a recess with relation to the shaft. The inner part of the shaft is made hollow to receive a rod which passes through it, and to the inner end of which is attached the grooved disc. With the outer end of the rod is connected one end of a lever. The other end of the lever extends back into such a position that the driver can readily operate it with his foot to adjust the reel bars.

334. Collecting Dust in the Manufacture of White Lead.

The object of this invention is to utilize the lead dust which escapes in white lead factories after having passed through the separator in which the corroded lead has been separated from the uncorroded lead, so that a considerable saving be accomplished, and the health of the workmen be protected against the deleterious influences of the lead dust. The invention consists, principally, in the combination of an elevator with a casing or spout, through which the uncorroded lead is conducted on the elevator, which is submerged in a tank of water, so that the lead dust carried down from the separator is retained therein, and the uncorroded lead carried up by the elevator.

335. Combing and Mixing Tampico and Bristles.

This invention consists of movable endless chain holders, to which the tampico and bristles are carried by endless belt carriers, and so presented to said holders that they project about half their length or more from the side as they are carried slowly along past a comb, so arranged and operated that it combs out the projecting portions thus subjected to it. The invention also consists of a combination, in one machine, of two of these movable holders and combs with endless carrier belts so arranged that they take the partly combed stock from the first holders and comb, and reverse and transfer it to the second holders, so that the uncombed portion is presented to the second comb to be completed by it. The stock is laid on the endless carrier belts a little in advance of the holders, and spread and mixed as evenly as possible, so that it combs together. It may be run through the machine several times till the mixing and combing are satisfactory.

336. Improved Clothes Reel.

This invention relates to the horizontal revolving reels used for hanging clothes to dry, and it consists of an arrangement of tie rods or braces upon the upper side of the arms to reinforce and protect the spider in which the inner ends of the arms are secured.

337. Improved Rotary Engine.

This invention relates to two steam chambers and a rotary piston arranged between them, having similar spiral cavities in their adjacent faces. The chambers are provided with passages for the induction and eduction of the steam, and with passages for conducting the steam from the inlet to the outlet, passing successively through the cavities, so as to retain the steam and cause it to act by expansion upon the piston, causing said piston to make several revolutions before said steam reaches the outlet. The steam, acting upon both sides of the piston, balances it and limits its friction. The chambers are provided with bolts to enable them to be accurately adjusted to faces of the piston, and with grooves for containing water of condensation for lubricating said faces and packing them steam-tight.

338. Improved Combined Water Cooler and Filter.

This invention consists of a double-cased filter with a dead air space between; also of a partition in the inner case, dividing it into two compartments—one for the ice and the water to be filtered, and the other for the filtered water, with a filter in the bottom of the former compartment, arranged in three divisions, through which the water passes successively, the first and last containing gravel, and the middle one charcoal. The filter is also arranged with a sloping top, against which the filtering substances pack by granulation, so that the water must pass through them.

339. Improved Machine for Sorting Potatoes.

This invention relates to means whereby potatoes may be simultaneously screened and sorted; and consists in two inclined endless screens, the fine one arranged with its upper end projecting and sifting out only the dirt, while the latter is coarse and sifts out all the unmerchantable potatoes. It also consists in using cords and weights to operate with hooks in holding the bags.

340. Improved Letter Envelope.

This invention consists of a lock formed in the flaps of a paper envelope by a T-shaped slit in one, and a dovetail-shaped tongue in the other, so contrived that by folding the tongue, inserting it in the slit, and then unfolding it, a practicable lock is formed, which, when sealed, cannot be opened without mutilating the envelope to such extent as to clearly show that it has been opened.

341. Improved Machine for Making Window Sashes.

This invention is a device for facilitating the manufacture of window sashes; and consists in a guide for governing the position of the stiles and meeting rails of the sashes in sawing the dovetails and mortises for putting them together.